About the Book

"Eye and Vision Science: Researches and Innovations" is a comprehensive volume dedicated to the latest advancements in the field of ophthalmology and vision science. This book brings together contributions from leading experts and researchers, offering an in-depth look at recent breakthroughs and ongoing research efforts that are shaping the future of eye care.

It covers the latest technological innovations, such as advanced imaging techniques, artificial intelligence in diagnostics, and novel drug delivery systems. It highlights new clinical trials and translational research efforts that bridge the gap between laboratory discoveries and practical treatments.

Emphasis is placed on the integration of multidisciplinary approaches, combining insights from molecular biology, engineering, and clinical practice to develop holistic solutions for eye health.

The introduction sets up the reader to understand how these innovations are addressing current challenges in eye care and vision science, ultimately improving diagnosis, treatment, and quality of life for patients with visual impairments.

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Eye and Vision Science: Researches and Innovations

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Eye and Vision Science

Researches and Innovations

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Eye and Vision Science

Researches and Innovations

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Preface

The human eye, a marvel of biological engineering, has captivated scientists, researchers, and innovators for centuries. Our ability to perceive and interpret the world around us hinges on this complex organ and the intricate visual system to which it is connected. As the field of eye and vision science progresses, we find ourselves on the cusp of ground breaking discoveries and innovations that promise to enhance our understanding of vision and improve the quality of life for millions worldwide.

"Eye and Vision Science: Researches and Innovations" is a comprehensive exploration of the latest advancements in this dynamic field. This volume brings together contributions from leading experts, offering a diverse array of perspectives and insights into the fundamental mechanisms of vision, as well as the cutting-edge technologies and treatments that are transforming eye care.

The chapters within this book cover a wide range of topics, including the anatomy and physiology of the eye, the molecular and genetic underpinnings of vision, and the pathophysiology of ocular diseases. We delve into the latest research on visual perception, exploring how the brain processes visual information, and present innovative diagnostic techniques that are enhancing early detection and treatment of eye conditions.

One of the most exciting aspects of contemporary vision science is the rapid development of new technologies and therapeutic approaches. This book highlights pioneering work in areas such as gene therapy, regenerative medicine, and the use of artificial intelligence in ophthalmology. These innovations hold the promise of not only restoring vision but also of preventing vision loss in ways that were once considered science fiction.

As we compiled this book, our goal was to create a resource that is both informative and inspirational. Whether you are a seasoned researcher, a clinician, a student, or simply someone with a keen interest in eye and vision science, we hope that the insights and knowledge contained within these pages will deepen your understanding and spark new ideas for future research and innovation.

We are grateful to the contributors who have shared their expertise and to the readers who continue to support and advance the field of eye and vision science. Together, we can look forward to a future where the gift of sight is protected and enhanced for all.

Acknowledgements

The creation of "Eye and Vision Science: Researches and Innovations" has been a collaborative endeavour that would not have been possible without the support, dedication, and expertise of many individuals and organizations.

First and foremost, we extend our heartfelt gratitude to the contributing authors. Your commitment to advancing our understanding of eye and vision science, combined with your willingness to share your knowledge and research, has been instrumental in shaping this book. Your contributions are the foundation upon which this volume stands.

We are deeply appreciative of the peer reviewers who provided invaluable feedback and insights. Your thorough evaluations and constructive critiques have ensured the highest standards of academic rigor and clarity in this work.

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. Your ongoing investment in scientific inquiry and innovation is crucial to the progress of our field. We are particularly grateful for the funding agencies whose financial support has enabled the research featured in this book.

We also wish to acknowledge our colleagues and collaborators whose discussions and shared knowledge have enriched the content of this book. Your intellectual generosity and enthusiasm for eye and vision science are truly inspiring.

Our sincere thanks to the editorial team for their hard work and dedication. Your meticulous attention to detail and unwavering commitment to excellence have been vital in bringing this project to fruition.

We are grateful to our families and friends for their patience, encouragement, and support throughout the preparation of this book. Your understanding and unwavering belief in our work have been a source of strength and motivation.

Finally, we extend our appreciation to the readers of this book. Your curiosity and passion for eye and vision science drive the continuous exploration and discovery that propel our field forward. It is our hope that this

book will serve as a valuable resource and inspire further research and innovation.

Thank you all for your contributions and support.

Contents

Chapter - 1

Development of Keratoconus after Collagen Cross Linking

Abstract

Keratoconus is a Bilateral, Progressive non-inflammatory corneal disorder. It is creating usually central thinning of the cornea and cornea is become ectatic. Here it is notified that progression of the keratoconus in a period of one year after Collagen Cross Linking.

Aim: Here to evaluate about the progression of keratoconus within and after one year of Collagen Cross Linking and it is keratoconus grading system.

Methods: Here corneal thinning is assessed before and after operative condition and it is compared regarding the situation of Keratoconus. Here followed Scheimpflug corneal tomography- Pentacam.

Results: Here it is found that one eye had keratoconus with stage I-II, 6 eyes had keratoconus with stage II, 4 eyes had keratoconus with stage III, 9 eyes had keratoconus with stage III-IV. There were statistically insignificant changes of keratoconus in a month after the surgery and $p>0.05$ and no progression was found to the preoperative stage.

Conclusions: Here it is showed that corneal cross-linking can control the keratoconus which was assessed by key corneal topographic parameters. It is analysed that within a year after Corneal cross-linking in keratoconus there was no significant progression. So, it is decided that CXL is a safe and most effective procedure during keratoconus treat.

Keywords: Keratoconus, cross linking, abcd gradation system, pentacam, medical, poverty, community, society.

Introduction

Keratoconus is a corneal degenerative condition which usually affects bilaterally [1]. It is characterized by thinning, ectasia and increase in the curvature which is a threat to visual health [2]. It is progressive in nature. Some interventions are to be made to prevent the disease from deteriorating. One of the most promising therapeutic approaches is corneal cross-linking surgery which slows down its progression [3]. In this study, stability of Keratoconus is

evaluated after one year of post-surgery to know the efficacy of corneal cross-linking surgery by its grading system.

The grading system of keratoconus is used for diagnosing the severity of the disorder. For assessment of Keratoconus, Pentacam and corneal tomography was used for pre and post-operative measurements [4]. By this grading we can check the impact of corneal cross linking progression over a period of 12 months [5].

To understand the effectiveness of Keratoconus progression is essential for clinicians as well as researchers. This research provides the outcomes of long time outcomes of the surgery. The aim of this study is to identify the safety measures and efficiency of treating keratoconus with corneal cross linking procedure.

Methodology

A prospective cross sectional study was done to investigate the efficiency of effect of corneal cross linking on keratoconus subjects over a period of 12 months. Ethical approval was taken and informed consent was taken. Subjects who were diagnosed with keratoconus and corneal cross linking surgery was performed was included in the study. Subjects having ocular or systemic complications other than keratoconus, pregnancy and subjects with conformed diagnosis but prior to corneal surgery was excluded from the study.

The corneal surgery procedure involves standard epithelium off technique by application of riboflavin eye drops, then UV A light is exposed with proper safety measures. Data collection includes pre-operative assessment which includes thorough ocular examination and ABCD grading system was utilized by Pentacam. Follow ups were taken after 1 month which is followed by 6 months and then one year follow up. Post-operative measures assessment with Pentacam and monitoring any complications or adverse effects.

Outcomes were measured on primary as well as secondary basis. Primary outcomes include changes in stage of Keratoconus by grading system through Pentacam. Secondary outcomes include changes in visual acuity and topography parameters. Paired t test and ANOVA test were utilized with value of $p < 0.05$.

Ethical considerations follows Declaration of Helsinki principles. Informed consent was taken by each and every subject which ensures privacy, confidentiality and voluntary participation.

Results

Here cohort 67 subjects were diagnosed with keratoconus who followed CXL and here distribution of keratoconus stages were like this: One eye as

Stage I-II, six eyes as Stage II, four eyes as Stage III, and nine eyes as Stage III-IV. Here main focus is to investigate the changes of keratoconus after CXL within 12th month. Here paired T test was applied for statistical analysis but insignificant result was found with comparing post-operative changes and within one month after the surgery ($p > 0.05$). There are insignificant changes in keratoconus between preoperative stage and postoperative stages. In this research came to know about outcome of Visual Acuity after CXL in keratoconus matter. Among 67 subjects, 45 subjects experienced stability of vision, 18 subjects show improvement and 4 subject shows deterioration of visual acuity in percentage 67.2% subjects experienced stability of vision, 26.9% subjects show improvement and 5.9% subject shows deterioration of visual acuity. Corneal parameter is evaluated by corneal topography meticulously and statistical analysis was held thoroughly.

In this analysis, topographic measurements were taken over a period of 12 months which shows mean value of keratometry, maximum keratometry and statisticaly insignificant changes in corneal astigmatism which supports that corneal cross linking therapy prevents the keratoconus progression.

For statistical analysis, paired t test was applied for continuous variables and non-parametric tests were applied wherever required. Significant changes are not found in stages of keratoconus and topographic parameters along with increase in visual acuity which collectively shows that CXL is effective in treating keratoconus.

Table 1: Stages of Keratoconus with Distribution with baseline

Keratoconus Stage	Number of Eyes
I-II	1
II	6
III	4
III-IV	9

Table 1: Among 67 subjects here keratoconus stages were showed with number of eyes.

Table 2: Statistical Analysis with Changes of Keratoconus Stage

Comparison	p-value
Postoperative vs. 1 Month After Surgery	> 0.05
Postoperative vs. Preoperative	> 0.05

Table 2 shows p value of Postoperative vs. 1 Month after Surgery and Postoperative vs. Preoperative with Changes of Keratoconus Stage with statistical analysis.

Table 3: Distribution of visual parameters with Changes of Keratoconus Stage

Visual Acuity Outcome	Number of Subjects
Stability	45
Improvement	18
Mild Decrease	4

Table 3 shows illustrates the distribution of visual acuity outcomes at the one-year follow-up.

Table 4: Parameters of Corneal Topography within 12 Months

Corneal Parameter	Mean Change (±SD)
Mean Keratometry (K)	0.12 ± 0.08 D
Max Keratometry	0.22 ± 0.15 D
Corneal Astigmatism	0.18 ± 0.12 D

Table 4 shows the mean changes in key corneal topographic parameters over the 12-month period following CXL.

Discussion

In this study we came to know about the effectivity of the CXL for stabilizing of Keratoconus progression within a 12^{th} month period. It emphasizes about the heterogeneity of the study cohort. By the statistical analysis we came to know that there is in significant changes in keratoconus stages and comparing postoperative stages within the stipulated period of time. So it is confident that CXL positively control the prog Nression of Keratoconus and may be sometimes previously it is considered as a therapeutic intervention.

Limitations of the Study

While it is promising but there is some considerable limitation in this study and that is short period of time. It is expected that longer duration is most essential for it. Additionally, there has some bias of potential selection procedure which can impact on inferential of the findings.

Conclusion

Here we came to know about the effectivity of the CXL for the keratoconus progression. There is in significant changes is found for progression of keratoconus by the data of corneal topographic parameters. Here clinical implications are very positive of CXL and provided effective result for the same.

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Chapter - 2

Effectiveness of Syntonic Phototherapy in Management of Amblyopia

Abstract

Purpose: Here scientific evidence is analysed and changes found in visual function and its effectivity of syntonic phototherapy.

Methodology: The synonym of the light therapy is considered as Phototherapy and health conditions. This Syntonic phototherapy is used in various purposes and it is specially used in vision but also used in amblyopia for vision betterment with improved visual acuity and the age range is considered 10 to 60 years and photopic stimulation is used intermittently. Shows improvement in Strabismic Amblyopia and Anisometropic Amblyopia and sympathetic and parasympathetic nervous systems balanced is maintained here. Here irradiates light is produced to the retina and it is a non-invasive technique, incandescent light is used with some required filters with required wavelength. Relative studies were find out from Scopus, Medline, Web of Science and PsycINFO since 1980 till 2022 and 197 articles were identified. In this study here in vision therapy syntonic phototherapy is considered to use and based as medical studies. Any kind of medical cases were excluded.

Here 8 clinical studies were included among of them 5 are pseudo-experimental studies and post pseudo-experimental studies are 3. Here tool was introduced (it is grade tool) for evidence base purpose and for data analysis soft table were considered.

Result: Here several outcomes were achieved and that is visual symptoms, deviation (Phoria/Tropia), visual acuity, visual fields and it is functional, stereopsis contrast sensitivity and reading abilities. This result shows insufficient scientific effectivity of syntonic phototherapy to produce visual function changes.

Conclusion: In this review no reliable evidence for the effectivity of syntonic phototherapy for visual function changes. Due to insufficient scientific evidence treatment for visual anomalies is suffered.

Keywords: GRADE tool, Visual anomalies, Phototherapy, Quality of evidence, medical, poverty, community, society.

Introduction

Amblyopia is a visual disorder and it is characterized by reduced visual acuity in one or both eye due to inadequate visual stimulation during the critical or plasticity period of visual development [1]. It is considered as a lazy eye also. Traditionally Amblyopia is managed by these methods like occlusion therapy, corrective lenses, and vision training [4]. However now a days Syntonic phototherapy is applied to management the amblyopia and considered as an alternative therapy. This therapy balanced between the sympathetic and parasympathetic nervous systems through the non-invasive irradiation of light on the retina [2].

Inspite of these claims, the scientific community has established a consensus on the effectivity of Syntonic phototherapy in provide significant improvements in visual function for individuals with amblyopia. The existing scientific evidence through a systematic review and meta-analysis is need to thorough examination. After the critical assessment the paper aims to contribute to the literature employing the mentioned tool to evaluate the quality of evidence, and providing a comprehensive analysis of the outcomes related to symptoms on visual parameters, visual fields related to functional, visual acuity deterioration, contrast sensitivity deterioration, ocular deviation, stereopsis, and reading abilities [3].

These clinical studies conducted between 1980 and 2022, this research shows the gap in knowledge regarding the effectiveness of syntonic phototherapy in the management of amblyopia. These analyses are significant and potential to inform clinical practices and it is future for guide for research purpose optimizing therapeutic interventions for individuals with visual anomalies.

Methodology

In methodology it is systematic approach to gather, assess, and analyse the existing scientific proof on the effectivity of mentioned phototherapy in the management of amblyopia. Here Cochrane approach for systematic reviews is considered and here extensive search was conducted find out from Scopus, Medline, Web of Science and PsycINFO since 1980 till 2022. Here in equivalent control group pseudo-experimental studies were included in this study and pre-post pseudo-experimental studies, while medical cases were excluded. Here data were collected on these focused reasons like participant demographics, intervention details, and outcomes related to visual symptoms, V/A, C/S, functional visual fields, Ocular deviation, stereopsis, and reading abilities. To assess the quality of evidence the GRADE tool was employed in

this study. On this study study design, limitations, consistency, and generalizability were considered for rigorous evaluation and to determine the certainty of evidence. Here quantitative synthesis, a meta-analysis was conducted using statistical software to calculate effect sizes for visual representation. Here sub group analysis was conducted due to acknowledged of heterogeneity, examining amblyopia subtypes, age groups, and intervention variations. During evaluation ethical consideration were taken but usually no required to follow ethical consideration.

Results

In this study systematic review and meta-analysis were assessed thoroughly and it is conducted between 1980 and 2022, provides a thorough examination of the effectivity of syntonic phototherapy in managing amblyopia. Seven critical visual outcomes were assessed and that is on visual parameters, visual fields related to functional, visual acuity deterioration, contrast sensitivity deterioration, ocular deviation, stereopsis, and reading abilities. Here statistically insignificant improvement is found following syntonic phototherapy. About visual symptoms statistically insignificant result were found ($p = 0.317$), convoyed considerable heterogeneity ($I^2 = 67.3\%$) among the studies. About visual fields statistically insignificant result were found ($p = 0.426$), with a high level of heterogeneity ($I^2 = 73.8\%$). Statistical insignificant visual acuity outcomes were found ($p = 0.289$), and heterogeneity persisted ($I^2 = 68.2\%$). Statistical insignificant contrast sensitivity outcomes were found ($p = 0.542$), with significant heterogeneity ($I^2 = 75.6\%$). Statistical insignificant deviation outcomes were found ($p = 0.381$), with significant heterogeneity ($I^2 = 69.4\%$). Statistical insignificant Stereopsis outcomes were found ($p = 0.219$), with significant heterogeneity ($I^2 = 71.5\%$). Statistical insignificant reading abilities outcomes were found ($p = 0.163$), with significant heterogeneity ($I^2 = 72.7\%$).

This table summarizes the meta-analysis of Visual outcomes of presenting pooled effect sizes 95% confidence intervals, p-values, and I^2 statistics for each visual outcome studied.

Table 1: Meta-Analysis Results for Visual Outcomes

Visual Outcome	Pooled Effect Size (95% CI)	p-value	I^2 (Heterogeneity)
Symptoms with Visual system	0.12 (−0.05, 0.29)	0.317	67.3%
Visual Fields of functional	0.08 (−0.12, 0.28)	0.426	73.8%
V/A	0.14 (−0.08, 0.36)	0.289	68.2%

CS	0.05 (−0.18, 0.28)	0.542	75.6%
Ocular Deviation (Phoria/Tropia)	0.11 (−0.09, 0.30)	0.381	69.4%
3rd grade of BSV	0.18 (−0.06, 0.42)	0.219	71.5%
Reading ability	0.21 (−0.03, 0.45)	0.163	72.7%

This table summarizes the GRADE assessment of evidence certainty for each visual outcome. Here evaluation of study limitations, inconsistency, indirectness, imprecision, and the potential impact of publication bias on the overall quality of evidence.

Table 2: GRADE Assessment of Evidence Certainty

Outcome	Study Limitations	Inconsistency	Indirectness	Imprecision	Publication Bias	GRADE Evidence
Visual Symptoms	Moderate	High	Low	Moderate	Not Assessed	Low
Functional Visual Fields	Low	High	Moderate	Low	Not Assessed	Very Low
Visual Acuity	Moderate	Moderate	Low	Low	Not Assessed	Low
Contrast Sensitivity	Low	High	Moderate	Moderate	Not Assessed	Very Low
Deviation (Phoria/Tropia)	Low	Moderate	Low	Moderate	Not Assessed	Low
Stereopsis	Low	Moderate	Low	Moderate	Not Assessed	Low
Reading Abilities	Low	High	Low	Low	Not Assessed	Very Low

Discussion

In this study included eight clinical parameters in the meta-analysis provided a healthy foundation, the overall results suggest insignificant improvements across various visual outcomes. The heterogeneity observed among the studies underscores the challenges in establishing a consistent therapeutic effect.

Here comprehensive analysis is conducted on effectiveness of syntonic phototherapy in managing amblyopia and came to know the potential clinical implications. While eight clinical parameters in the meta-analysis provided a healthy foundation, the overall results suggest insignificant improvements across various visual outcomes. Among the studies heterogeneity observed is observed and underscores the challenges in establishing a consistent therapeutic effect.

Clinical Implications

Due to lack of proof for supporting the effectivity of Syntonic phototherapy for amblyopia has direct implications for clinical practice. So, during the usage of Syntonic phototherapy medical practical should be cautioned for treatment of amblyopic management. Whereas occlusion therapy and corrective lenses, may remain more reliable choices till further research establishes on the efficacy and safety of syntonic phototherapy.

Limitations of the Study

Here several limitations are considered, observed heterogeneity among the included studies introduces variability that may unclear the true effects of syntonic phototherapy. Here diversified study designs, intervention protocols, and participant characteristics could contribute to this heterogeneity. Here evidence certainty came from GRADE assessment but most outcomes rated as low or very low, indicating potential biases and limitations in the available evidence.

Conclusion

In conclusion, this systematic review and meta-analysis provide insufficient evidence to support the clinical effectivity of Syntonic phototherapy for significant improvements in visual system for individuals with amblyopia. Due to low evidence certainty underscores the need for more difficult and standardized research in this domain. Future research should order well-designed, controlled studies to elucidate the potential benefits and limitations of syntonic phototherapy.

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Chapter - 3

The New Vision in Blind with Bionic Eye

Abstract

There are millions of people those who are wearing spectacle with compromised vision. Among them are considered blind and very few are wearing spectacle glasses. By this they are availing their life with compromising with day to day. So, it should be need for those people who are facing this issue day to day for alternative way by which brain will enlighten by the sight of the world. Now a days technology has enhanced and try to make this problem shorten. Now technology is improved strongly and expected that whole human body will be controlled by a small single electronic chip. Now it is expecting that this technology will work properly on prosthetic eye. Now this vision is referred to artificial vision through Bionic eyes. This chip works on the damaged retina with rods and cones of the organ for vison and this chip will be implanted by the microsurgery. With the help of biotechnology and linking to electronics the scientist is expected to restore vision of visual impaired person with the help of this dynamic chip. There is a big hope for the blind eye of the uses of bionic eyes. This technology can improve the individual's life style and else.

Keywords: Electronic Microchip, Artificial Silicon Retina, MARC System, Digital Camera, Implantation, medical, poverty, community, society

Introduction

For human being vision is the fundamental right and provide the enlighten world around them. Individuals who are suffering with imperfect vision using corrected spectacles following compromising their lifestyle and who are blind their lifestyle is worst and they are expected to see the world like others. It may be possible to grasp a latest technology. This research paper explores the innovation of bionic eyes where by these collaboration like the branch of electrical, computer, biomedical and mechanical plays an important role to develop this device to enrich the goal.

Background

Usually, visual impaired patient is using traditional visual aids over a year with limitation. Here researcher is more forward regarding this matter

provided an innovative solution: Bionic Eyes. These devices provide beyond the vision and here electronic microchip is implemented and helpful for the multifaceted functions of the human retina, cones, and rods. Here intervention of biomedical expertise which helpful for to make the way for the development of Bionic eyes and try to reduce the visual impairment and challenges also.

Engineering disciplines intersection

In this paper it is mentioned that in Bionic eyes engineering disciplines are involved to reduce the complexity of vision problem. Biomedical engineer plays an important role to design this microchip that work out on damaged retina and on rods and cones of the retina. Computer engineers contribute plays an important role like digital camera and interpretation of visual data for Bionic eyes. Computer engineers contribute plays an important role like electronic motherboard in Bionic eyes and it is mechanically supported.

Research objectives

The primary objectives of this study is to make a high standard Bionic eyes to reduce visual trouble with a strong intervention of biomedical, computer, electrical, and mechanical engineers. This technology highlights the technological advancement, reduce challenges and improvement of quality of life and provide artificial vision.

Importance of bionic eyes

In this research paper it is showed that these Bionic eyes provide exclusive vision for improvement of quality of life and vision by implementation of microchip by microsurgery. This mechanism is expected to establish by the help of technical support of biomedical, computer, electrical, and mechanical engineers.

Development of bionic eyes with historical background

Initial attempts and Milestones

Traces the historical background of bionic eyes of early attempts for restoring vision by advance technological support. The starting phase was very simple prototypes and experimental devices that provide for to start for ground work for the classy system whatever seeing today. Artificial Silicon was first attempted to implant on the retina and it was the early adaptation, the development of the bionic eyes reflects the determination of the researchers and whole team who faced a lot of challenges.

Electronic microchips development

In this research the main focused on progression and development of the bionic cheap which will be placed on the human retina by micro surgery. In this research electrical engineer, computer engineer, biomedical engineer and mechanical engineer plays an important role to progress the study.

Contribution of biomedical engineering to bionic eyes

Techniques of microsurgery for implantation of bionic eyes

In this research and in study there is a considerable role of biomedical engineer for successful Implantation of bionic eyes in microsurgery. Here successfully implanted electronic microchip on the retina and provide vision considerably. This research has been conducted with the help and collaboration with Ophthalmologist and biomedical engineer and with others also. It is established as invasive procedure and ensure about safety and efficacy for implantation on the retina and provide the reduce of the complication and risks. Here biomedical engineers at first understood about the damaged retinal complexity and characteristics of the microchip and its replicating nature. In this bionic chip there is a biomimetic features like photo receptor like elements which provide natural vision.

Contribution of computer engineering to bionic eyes

In this research and in study there is a considerable role of computer engineer for successful Implantation of bionic eyes in microsurgery. In this micro surgery computer engineer provide considerable role for capturing real time image. Here biomedical and computer engineer concept works simultaneously for capturing visual information from the surrounding environment. By the computer engineer here emphasize on camera technology, resolution, processing of image and synchronizing of capture data in the electronic microchip. But visual data interpretation is a significant challenge for advancement of bionic eyes. But this professional provides standard algorithms for visual image processing and Artificial intelligence which enhance visual stimuli. By continuous refining of algorithm engineer can able to provide speedy data interpretation and contributes high standard and most needful bionic eye which provide good visual experience.

Contribution of electrical engineering to bionic eyes

In this research and in study there is a considerable role of electrical engineer for successful Implantation of bionic eyes in microsurgery. The main role of the electrical for implantation of bionic eyes in microsurgery is creation of electronic circuits in the bionic chip.

In this study Electrical engineers, computer engineers and biomedical engineers provide exclusive performance for bionic chip and provide more natural visual experience. In this research sensory feedback into bionic eyes are the major challenges.

It is noticeable that implantation of bionic eye on to the retina is also a unique challenge for mechanical engineer. Here biocompatible material and its unique structure provide most comfort for it and can provide artificial vision.

Here mechanical engineer collaborates with biomedical professional for develop minimal invasive surgical technique for implanting bionic eyes.

Ethical Considerations and Future Directions

In this study and research potential advancement is continuing and improvement of technologies will provide and enhance good future of bionic eyes. It's cutting edging material researcher and engineer combine to provide artificial vision.

Ethical considerations

In this research ethical consideration is most important and now a days its usage is increasing. This ethical consideration is related to artificial vision, accessibility, privacy, affordability. This ethical consideration is needed for recognizing and addressing for development in the field of bionic eyes.

Conclusion

It is a collaborative study it means biomedical engineer, computer engineer, electrical engineer and mechanical engineer works together to make a proper bionic eye for alternative vision for rod and cons defect, retinal defect and else.

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Chapter - 4

A Review Study on Retinal Complication's Due To Diagnosis Delay In Case of Congenital Glaucoma

Abstract

Significances: Glaucoma is a genetically inherited disorder and that can affect ocular health since childhood. Sometimes developmental issues may be responsible for the glaucomatous changes in eye such as increasing or abnormal density of collagen meshwork at the drainage angle and trabeculum may hamper drainage of aqueous humour may tend to glaucomatous tendency. In some cases paediatric patient also can be seen with enlarged eye ball termed as Bupthalmos. In case of diagnosis delay it can slowly hamper visual field and visual acuity also. Major retinal disorders like optic atrophy, permanent optic nerve damage, corneal edema and stretching may cause loss of visual acuity. Beside this, elevated level of intra ocular pressure also responsible for axial length stretching and that is responsible for myopia progression with amblyopic changes. High intra ocular pressure may affect anterior segment like angle closer condition, anterior synechia, corneal edema, Haabs striae that may affect severe vision loss. In this article we have studied similar articles related with congenital glaucoma to find out complications and manifestation and its impact in case of delayed diagnosis and if left untreated.

Objectives

- Discussion about the causes and complications due to glaucoma and primary congenital glaucoma.
- Glaucomatous changes related with cornea.
- Myopia progression, Bupthalmos, Megalocornea and its relation with congenital glaucoma.
- Associated diseases connection with refractive media.

Aim of study

Congenital glaucoma is type of a rare genetically inherited disorder that affects vision gradually from the childhood. Glaucoma may cause permanent vision loss if it remains undiagnosed but glaucoma rarely has warning signs

and symptoms. In some cases it also associated with different type of developmental anomalies that can be related with ocular anatomical structure or growth. Such as developmental abnormalities related with trabecular meshwork and drainage angle may reduce aqueous humour drainage rate which plays a vital role to induce glaucomatous changes with elevation of intra ocular pressure level. It is very difficult to quick diagnose glaucoma cases from the early stage but it can be controlled if treatment started from the beginning. Eye check up with proper history and diagnosis with follow up is helpful for controlling the glaucoma progression to restore vision. In this study we will discuss different types of glaucoma and glaucomatous changes due to primary congenital glaucoma with its complications if remain untreated and relation with other developmental anomalies.

Expected outcome

- After study from the maximum number of article it can be estimate that e diagnosis from the early stage is necessary to control the glaucoma progression and gradual vision loss. Congenital glaucoma with the associated sign and symptoms like corneal striae, eye ball progression, enlarged cornea, congestion in different ocular parts, optic nerve damage, myopia progression, light sensitivity, high Intra ocular pressure, visual field limitations or reducing etc. can be the early sign and symptoms that should be followed up properly.
- Patient education is also needful to spread awareness so that they will be aware about the causes of congenital glaucoma and regular intervention with follow up may reduce the threshold of glaucomatous visual field defects and slower the progression rate.

Index Terms **- Angle closure glaucoma, glaucomatous changes, high IOP, Bupthalmos, Megalocornea**

I. Introduction

Glaucoma can be defined as a bunch of ocular disorder that can reduce or damage vision permanently and it is irreversible most of the time. In such cases optic nerve become damages and lost its ability to convey visual signals to the brain [1]. In some cases it also can cause with normal level of intra ocular pressure termed as normal tension glaucoma. In most of the cases glaucoma shows no significant warning signs & symptoms to indentify glaucoma tendency but gradually affect and damage visual field starts from the peripheral field towards the central vision. Normally it affects the older age people but in some cases it can be seen during early age of life even it can be achieved by born. In such cases it is termed as primary congenital glaucoma

first invented by Hippocrates (460-377 BC) with some other sign like enlarged eyeball and Berger invented the relations with intra ocular pressure also [2].

Glaucoma is type of genetically inherited disorder but also occurred due to developmental anomalies also. Other associated signs like enlargement of the eye ball, Bupthalmos, hydropthalmos, myopia progression, corneal striae etc. Defected aqueous humour drainage through the trabecular Meshwork at the drainage angle may reduce drainage rate may induce high IOP later affect optic nerve and gradual fall of visual acuity permanently. Proper eye consultation with follow up, glaucoma diagnosis with proper investigation and follow up needed since infant age to observe normal eye development so that glaucoma can be diagnosed and treated from the beginning stage to control its progression and vision can be protected [3].

2.1 Literature review

Based on paediatric age category glaucoma can be classified as [4]

- **New born:** Patient affected by glaucoma disorder since birth and it is found that during the intrauterine life IOP elevated due to developmental disorder and patient born with enlarged size of eye ball.
- **Infantile:** Patient affected by glaucomatous changes started from the 1st month after birth to next 3 years of age. Also termed as primary congenital glaucoma (PCG).
- **Juvenile:** Patient affected by glaucoma and elevated intra ocular pressure started after 3 years of birth and in some cases also occurs before the adult stage.
- According to the Hosking it can be said as [5]

Primary: In case of defective anterior chamber drainage system through the drainage angle and trabecular meshwork may increase IOP level ultimately affect eye with glaucomatous changes.

Secondary: In case of developmental anomalies like iris coloboma, aniridia, abnormal blood vessel and collagen precipitation may cause congestion to the drainage angle which may interfere the rate of aqueous humour drainage rate and increase intra ocular pressure level.

Etiologic review

According some previous research work it is found that glaucoma is a type of genetical inherited disorder but in case of primary congenital glaucoma maximum is found as not linked with any other previous family history. About

the congenital glaucoma or glaucomatous changes related with developmental abnormality linked with consanguineous marriage. About 90% cases found as linked with consanguineous marriage and other 10% found connected with the family history [1].

Responsible gene found GLC3A that connected with CVP1B1 gene and mutations are responsible for such type of congenital glaucoma formation [6].

Epidemiology

Due to connection with consanguineous marriage, in Saudi Arabia maximum cases found. Saudi Arabia at least 1/2500 patient affected by primary congenital glaucoma [7].

In United States also found male and female ratio as 3: 2 while in Japan it is found 6:5 [7].

Pathophysiology

In a research study it is found that excessive collagen precipitation at the trabecular meshwork located at the drainage angle may be responsible for the glaucomatous changes.

Anderson *et al.* said about the collagen meshwork density that deteriorate the aqueous humour drainage rate as the maximum aqueous humour outflow occurred at the drainage angle based on trabecular meshwork.

Decreased amount of aqueous outflow may influence the elevated level of IOP and glaucomatous changes early age onset of life.(8) Anterior part of the iris root also inserted at the drainage angle may cause congestion to the drainage angle responsible for the lowering rate of aqueous humour outflow and increasing intra ocular pressure.

Clinical examination & evaluation

Glaucoma can reduce visual acuity and cause permanent vision loss. So early diagnosis and treatment is necessary to restore the remaining vision. As per epidemiological studies we have found that the gene mutation and consanguineous marriage is responsible for the glaucoma progression. In many cases so it is needful to investigate all about family history and marriage history also.

The clinical investigation discussed as a triad consists of:

- Blepharospasm
- Excessive tearing
- Excessive light sensitivity [9].

During childhood age these symptoms should be undergo with detail glaucoma investigations properly. In some cases glaucoma also found associated with enlarged eye ball, slight bluish appearance of eyes, progressive vision loss, unequal refractive power, amblyopia tendency.

Clinical examination can be described as:

- Fixation behaviour
- Cornea & Sclera
- AC Depth.
- Pupillary function.
- Retina evaluation
- Intra ocular pressure check etc.

Evaluation part

Fixation behaviour

→ Light sensitivity can be evaluated and beside this extra ocular motility test also necessary. In some glaucoma cases Nystagmus and exo-deviation found with poor fixation quality [9].

Cornea & Sclera

→In case of congenital glaucoma sclera can be found with slight bluish appearance with thinning changes and enlargement of the eye ball with larger cornea(12mm or excess). Beside this different types of degenerative changes can be seen in descemets layer termed as Haabs striae. Corneal opacity can be developed with fluid accumulation may cause severe vision loss [9].

AC Depth

AC depth can be measured with VH grading and gonioscopy.

Iris & Pupil

Normal anatomical structure of iris and ciliary body is needed to maintain adequate aqueous humour dynamic flow and secretion. In case of developmental abnormality may deteriorate rate of aqueous humour drainage may lead to severe glaucomatous changes. Iris coloboma, aniridia, iridodonesis etc. also found as associated with the glaucoma onset during the early ages of life [9].

IOP

In case of congenital glaucoma, intra ocular pressure noticed with a elevated level in maximum cases. Excessive IOP may enhance eye ball

progression, myopic changes, corneal changes and compression to the optic disc [9].

Optic Disc

Larger cup disc ratio is the possible sign and symptoms of congenital glaucoma. Elevated intra ocular pressure may lead compression to the posterior pole of eye ball and the optic disc that ultimately responsible to optic atrophy and permanent vision loss [9].

Corneal thickness

Pachymetry performed to evaluate corneal thickness. Enlargement of the eye ball may cause stretching of the outer surface coating may be responsible for the corneal thinning and opacity formation [9].

Axial length

Due to congenital glaucoma and ocular enlargement in size also responsible for increasing axial length more than 22mm [9].

Retinal layers

OCT performed to observe retinal layers with advancing level of glaucomatous changes. Retina thinning, degeneration, detachment associated with glaucoma may cause permanent loss of visual acuity. In case of glaucoma disorder associated with retina disorder may initiate visual field loss from the peripheral to the central. Retinal nerve fibre layers, ganglion cell layers should be evaluate properly as part of glaucoma evaluation [14].

Treatment & consultation

About glaucoma management, primary noticeable symptom is raised intra ocular pressure that should be controlled. In some cases glaucoma also observed with normal IOP called as normal tension glaucoma but maximum cases from the congenital cases, high intra ocular pressure may be observed [2].

IOP normally maintained by aqueous humour dynamic flow about its secretion and drainage without complications or any other congestion [16]. In case of excessive secretion or lowering drainage quantity may induce elevated IOP level and ultimately lead to the glaucomatous changes.

Topical eye drop & medication preferred by oral route of administration may be prescribed daily basis to maintain IOP within the normal level. Glaucoma medication normal designed with the properties that it can enhance trabecular meshwork drainage to control intra ocular pressure or can reduce rate of aqueous humour secretion [2]. Based on this properties glaucoma drugs can be classified as:

- Alpha-Adrenergic agonist (example: Brimonidine)
- Properties: reduce aqueous humour secretion.
- Beta blocker (example: Timolol, Betaxolol etc)
- Properties: reduce aqueous humour seretion.
- Carbonic anhydrase inhibitor (example: Dorzolamide, Acetazolamide, Brinzolamide etc)
- Properties: Reduce aqueous humour production.
- Parasympathomimetic (Example: Travoprost, Latanoprost)
- Properties: Prostaglandin analogue used to increase aqueous humour drainage.

Alpha adrenergic agonist may cross the blood brain barrier and it may interfere with central nervous system which is responsible for depression, respiratory problem, dizziness etc. So it will be better to avoid for below 2 years old patient and used with risk benefit ratio for the patients age limit below 66 years old.(10)

Glaucoma treatment depends on patients age limit, disease acuteness and its progression level. In case of congenital glaucoma surgical treatment is also necessary for the patients with developmental anomalies with severe rate of glaucomatous progression. But surgical treatment also depends on the anatomical structure and corneal opacity. In case of anterior chamber closure due to collagen density at the trabecular meshwork or iris anterior root progression to the drainage angle then for such type of cases surgery is recommended [11].

If corneal visibility found with clear appearance at the anterior chamber angle then goniotomy can be performed. As per procedure drainage angle first layer cuts to make clearance to the aqueous humour and intraocular pressure can be controlled.

When trabeculotomy or goniotomy fails and drainage angle is also not visible enough for goniotomy, for such cases trabeculactomy is performed to lower IOP level. Under such procedures new drainage channel created for the aqueous humour drainage to the sub-conjunctival space. Due to drainage IOP decreased but conjunctival elevation part may be seen called as filtering bleb. During trabeculotomy aqueous humour drainage barrier is eliminated but during trabeculactomy new bypass created to connect with episcleral venous system [11].

In a another study conducted at Tunis city on the retinal dystrophy due to congenital glaucoma it is found that among 172 students survey 22.7%

students are affected by retinal dystrophy and congenital glaucoma. They stated that consanguineous marriage is responsible for the onset of congenital glaucoma [12].

Complications

Glaucoma is a bunch of disorders as per our discussion and findings it can be vision threatening and cause progressively irreversible loss of vision. So, early diagnosis, management and follow up is very necessary to save the remaining vision. But if glaucoma disorders lefty untreated it may cause permanent blindness suddenly and peripheral visual field loss also with other multiple structural anomalies. Congenital glaucoma with Bupthalmos (enlarged eye ball) may cause increased axial length with anterior to posterior diameter larger than 24 mm. ultimately responsible for retinal thinning, Scleral stretching and thinning, corneal opacity formation, corneal edema formation etc. Beside this retinal complications also can be formed by surgical management [12].

Some other complications also discussing here

- Hyphema (Blood precipitation at the anterior chamber)
- Anterior Chamber depth. (In case of glaucomatous changes like anterior chamber angle closing or opening.)
- Iridodialysis (Separated iris from the ciliary body).
- Retina detachment and vitreal detachment.

3.1 Conclusion

According the discussion we can estimate the congenital glaucoma is responsible for the lowering of visual acuity and irreversible blindness during the pediatric age category like new born, infant, toddler, preschool and school going etc. Early diagnosis is very needful for the patient to evaluate the glaucomatous changes during the developmental ages may reduce chance of glaucoma progression and lower chance of vision loss. In such cases proper history taking is needed because glaucoma is a genetically inherited disorder and any blood related found in family status need to undergo the glaucoma management so that while progression started it will be arrested by early diagnosis and proper management may reduce the chance of optic nerve damage. During the infant and first two years after birth patient is unable to report problems so proper parent counselling and training needed so that they can be conscious about the disease and spread awareness also to maintain regular follow up the vision development. During the diagnosis and investigation if patient found with enlarged eye ball, enlarged corneal diameter

and size, photophobia, blepharospasm, hazy corneal structure and appearance, excessive tear secretion must be checked under glaucoma investigation properly to reduce chance of optic nerve damage and vision loss due to glaucoma progression.

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Chapter - 5

Impact of Excess Technology Usage in Daily Life & Ocular Manifestation

Abstract

Significances

Day by day technology is becoming more developed and it plays a vital role in advancing our daily life style. But beside its scientific and necessary facts, it also has so many bad effects in our life when it crosses limit or over usage. In our daily life, in every sector of works & activities we are becoming upgraded, fast but depended on technology. For such purpose now we are spending a prolong time with Smartphone, tablet pc, laptop etc digital screen usage. At the professional sector daily basis more than 6 hours we are spending in front of digital screen continuously and it is significantly affecting our general health and ocular health also with increasing complications. During spending a spontaneous hours of digital screen exposure my cause severe ocular discomfort, fatigue, irritations, burning and watering with other adverse immune responses also like fatigue, accommodative disorders, convergence anomalies etc. Visible short wavelength powerful blue rays are responsible for ocular discomforts during excessively exposure. Sun is responsible as main source for high powerful short wavelength light rays that may trigger aging procedures and also hamper visual capabilities. But in the research studies we can see that light rays that coming from the digital screen is not as powerful to induce degenerative changes in our ocular health but slowly affect the normal physiology also. Ocular discomforts in maximum cases depend on the way to use the devices. During the office time due to the official workloads we forgot blinking but try to concentrate and focus the target objects at the digital screen continuously. Beside this under dry cold air conditioned room environment poor blinking rate enhance severe ocular dryness, low lacrimaration with allergic symptoms in many cases. Beside these, risk factors like, uncorrected refractive errors, squint and ocular devices etc. increase the level of ocular surface dryness that is called as “Digital eye screen exposure”. In this study through the research article we will try to find ocular manifestations, impact with eye stress, pain, congestions due to long time exposure.

Objectives

- Technology use in daily life and its affect on ocular and general health
- Discussion about dry eye symptoms and digital eye strain
- Ocular complications and pathophysiology related to excessive digital screen use.
- Prevalence of patients affecting by the computer vision syndrome among regular computer users.

Aim of study

In our daily activities and lifestyle requirements technology dependency reaches at the excess level that affecting our health on day to day life. Due to professional purpose, continuous laptop computer screen use affect ocular health and deteriorate the quality of vision and also trigger aging procedure that affect physiology of refractive surface and also increase chance of retinal degeneration. Beside this due to long time stay in indoor during the professional working time with the digital devices may cause peripheral defocus. Peripheral defocus in many cases responsible for myopic progression and pathological myopia. Beside this long time stay at indoor in front of digital screen with air condition may be responsible for lowering blinking rate and may increase dryness tendency. Also, besides the professional use nowadays, school going pediatric students are also suffering by digital device use and excessive near work with study load assessment, online classes, meetings, assignment note processing, etc. force pediatric students to use excess digital device for prolonged time. Excess digital screen use may lower blinking rate and harmful blue rays exposure also may cause ocular tightness, accumulative stress, eye strain, fatigue. We have studied so many research article regarding dry eye symptoms and digital eye strain. Here we will discuss about sign and symptoms of digital eye strain and its affect on ocular health, proper treatment and vision exercises with overall prevention tips for the digital screen users to take good care of eye health.

Expected outcome

- After study from the maximum number of article it can be estimate that atleast 80-90% computer users affecting by eye stress fatigue.
- In maximum cases prolong time digital screen and short wavelength blue light exposure affect ocular health with stress, tiredness, neck pain, ocular burning sensation, reflex watering, redness, IOP changes, Refractive errors progression etc.

- In maximum study focus on head and neck posture while using digital screen and lowering amount of blinking rate.

Keywords: Computer vision syndrome, dry eye changes, high IOP, digital eye strain, vision 20-20-20 exercise, blinking rate

Introduction

Day by day technology is becoming more developed and it plays a vital role in advancing our daily life style. But beside its scientific and necessary facts, it also has so many bad effects in our life when it crosses limit or over usage. In our daily life, in every sector of works & activities we are becoming upgraded, fast but depended on technology. For such purpose now we are spending a prolong time with Smartphone, tablet pc, laptop etc. digital screen usage. At the professional sector daily basis more than 6 hours we are spending in front of digital screen continuously and it is significantly affecting our general health and ocular health also with increasing complications. During spending a spontaneous hours of digital screen exposure my cause severe ocular discomfort, fatigue, irritations, burning and watering with other adverse immune responses also like fatigue, accommodative disorders, convergence anomalies etc. Visible short wavelength powerful blue rays are responsible for ocular discomforts during excessively exposure. During the office time due to the official workloads we forgot blinking but try to concentrate and focus the target objects at the digital screen continuously. Beside this under dry cold air conditioned room environment poor blinking rate enhance severe ocular dryness, low lacrimaration with allergic symptoms in many cases. Beside these, risk factors like, uncorrected refractive errors, squint and ocular devices etc. increase the level of ocular surface dryness that is called as “Digital eye screen exposure”. In this study through the research article we will try to find ocular manifestations, impact with eye stress, pain, congestions due to long time exposure.

Literature review

In a study conducted by Ugam Usga Onkar *et al.* during 2021 lockdown period observed through his research activity about the use of bright digital screen uses with maximum blue blue light exposure and its affect on ocular health. It is found that maximum patients affecting by digital eye strain are mobile users. About 97% and they have spent maximum time by watching social media updates is about 89.70% and it is increased during the lockdown period [2].

Complications found and noted as dry eye symptoms with reflex tearing, eye strain, neck pain, headache, eye strays, elevated IOP, etc.

In other research study, conducted by Lofty. F ISSA *et al*. at Saudi Arabia regarding use and impact of mobile and digital screen exposure.

At the present days smartphone, desk-top computers use becoming more popular day by day and gradually use of fixed or wired telephone becoming less popular. Beside this social media, newsfeed, education, entertainment etc. are all available in smartphone with high speed Internet service. High speed mobile network also responsible for spreading frequency radiation with an intolerable limit and all the devices with digital screen are used generally from very close distance that is responsible for inducing ocular stress and tiredness. Constant watching & observing also affect blink rate and induce reflex watering with severe dry eye syndromes. This also found that maximum female are most addicted compared to male with age limit 12-18 years old and they spent 4-6 hours per day. Among the described users 66% patients are students suffering from severe ocular dryness with burning sensation, redness. Health awareness study and campaign may help to reduce the prevalence of computer users suffering by digital eye strain.

High contrast with large amount blue light rays exposure and long term watching digital screen device also responsible for reducing blink rate that may be related to dry eye symptoms and excessive ocular stress level.

Impacts of technology use in daily life

About the present life structure it is very impossible to avoid the digital screen totally from the daily life as we are becoming more dependent on it especially on artificial intelligence basis devices. Constant use of digital screen more than 6-7 hours every day may cause serious complications that will be reflected on present discussion. It will not cause vision loss suddenly but triggering the risk factor that may lead to blindness conditions.

Harmful blue rays are responsible for causing more ocular complications because of short wavelength and high energy characteristics. Normally visible powerful short wavelength blue rays radiated by the sun but also found in maximum level from digital screen .LED screen, fluorescent light source etc. It causes tiredness of eye fatigue age related macular degeneration etc. [4].

In a study by Daniel Porter published on American academy of ophthalmology broadly discussed on the blue light effect on our ocular health [4].

According to the study blue lights are mentioned as short wavelength light rays also part of visible spectrum. Main source of blue right lays is from Sun and its radiation propagates from the sun to earth. It is mentioned that low

wavelength light from sun may cause degeneration and affect general with ocular health also found from several studies. But this natural blue rays also plays a vital role in our biological clock maintenance. Blue rays reduce our melatonin hormone secretions level that is responsible for maintaining sleeping cycles. So after the sunrise it spreads all the rays so that we can wake up and start our regular activities.

As per natural phenomena harmful level of Blue rays are normally limited by our atmosphere during past days but due to over pollution now the atmosphere and natural barrier levels are affected so harmful short wavelength rays are also reaching to our ground level with other violet and ultraviolet rays also. This is found that it can destroy our cells and trigger the degeneration level at retina, so protective eyewear is mandatory to avoid this kind of exposure[5].

As per natural phenomena we can observed that with moving the clock from noon to afternoon or evening the sunshine and raise sensitivity normally become decrease its brightness to regulate our regular hormonal activities but due to technology availability and excessive use, now we can see that night are like to becoming more brighter than the day time work due to artificial light sources. That affects our regular sleep cycle and cause tiredness. It increases our working hours with reducing rest levels [5].

While using a laptop or mobile screen with high brightness during night time may disrupt the sleep cycle as it inhibits the regular production of melatonin. Consequently, a decrease in the amount of sleep over time can lead to inadequate rest for our ocular physiology and nervous system also. Prolonged exposure to screens, especially at night, may also contribute to attention deficit.

Prolonged screen exposure, especially among children and adolescents, can lead to attention deficit-related issues. This is because the decreasing rest time and increasing workload gradually put pressure on their ocular structures, potentially resulting in unexpected seizures and spasms.

Digital screens emit much lower levels of light compared to sunlight, so there's no immediate risk of blindness. However, prolonged exposure can gradually and subtly affect our eyes. The extent of this effect depends on how we use the technology and the duration of our screen time.

Daniel *et al.* indicate that factors such as dry eyes and a low blinking rate can hamper the regular lacrimaration system, leading to reduced tear secretion and causing dryness.

Due to ocular surface dryness, a burning sensation occurs, which triggers reflexive tearing. Additionally, continuous and prolonged use of screens can lead to increased accommodation to focus on near objects, which may contribute to these symptoms.

- Ocular discomfort
  - Burning sensation
  - Watering eyes
  - Decreased visual activity
  - Severe headaches
  - Elevated IOP (Intraocular pressure)
  - Neck pain
  - Back vertebral pain

Another study in Canada found that increased screen usage may lead to sleep deprivation, obesity, and the progression of myopia [6].

Excessive mobile usage in the evening can significantly reduce sleeping hours, putting additional strain on the central nervous system, which lacks adequate rest and freshness. Consequently, this can lead to decreased quality performance [6].

Obesity: Mobile and computer activities can reduce the inclination to go outside, particularly among school-going individuals who are drawn to social media scrolling and indoor gaming. This decreased physical activity can lead to obesity, as fewer carbohydrates are utilized and instead stored in the body.

Myopia: Excessive indoor screen time, whether for education or entertainment, can contribute to the progression of myopia due to various factors. Prolonged near work, limited outdoor exposure, and reduced dopamine secretion or activity can all play a role. Additionally, stress and excessive accommodation may lead to accommodation spasms and myopia at a distance. Over time, these effects can result in fatigue and decreased accommodation efficiency, potentially leading to disability.

Development: After birth, newborns and infants begin a circular development process, gradually learning motor activities and analyzing techniques to interact with their environment. They follow clues from their surroundings and parents to learn how to talk, react, and handle various situations. However, with the widespread use of mobile devices, even paediatric patients are becoming increasingly reliant on technology for their development. Excessive mobile involvement can hinder a patient's growth and development, potentially leading to attention deficit disorders.

Dr. Satya Karna, in an article published in July 2023, highlighted the adverse effects of excessive use of laptop, PC, and tablet computer usage, also known as computer vision syndrome. He noted that excessive use and huge time spend constantly with digital screen functioning my induce computer vision syndrome. He mentioned all the complications related that as back pain, stress, ocular dryness, tiredness, lowering vision quality. Long-time blue light exposure also hampers sleeping and wake up cycle that may interfere ocular health with central nervous system [7].

In another study published at American Academy of Optometry during July 2015, Barbara L. Horn said about excess technology use and impacts to advice patients to avoid excess technology exposure to life that may interfere daily life and deteriorate quality of health. Complications are mentioned as focusing problems, lowering visual acuity, increasing amount of ocular stress, fatigue, tiredness, strain & burning etc. and all are associated to computer vision syndrome. Excess digital screen exposure from very close distance may cause degenerative changes during old age and responsible for aging progression [8].

A study published in the UK in June 2022, on the SpaMedica page, highlighted the impacts of technology on ocular health. It emphasized that prolonged use of tablets, mobile phones, and computers increases the risk of ocular complications. Blue light rays which is part of the visible spectrum but has a powerful dose at low wavelengths, is particularly harmful. While blue light from natural sources like the sun can have beneficial effects on consciousness levels and sleep-wake cycles, excessive exposure can lead to health problems, including age-related degenerative changes [8].

Moreover, pathological changes may occur due to severe dryness or infections exacerbated by high pollution levels. Unexpected low-wavelength rays from pollution can further aggravate vision problems by entering eye to disturb focusing and also trigger age related changes. Due to excess pollution level ozone layers in the atmosphere level not functioning enough to absorb the harmful rays and all these short wavelength rays are responsible for different types of health issue with ocular complications also such as eye strain, aging, disturbing sleep cycle etc. It is observed that 50-90% computer users patients are suffering from digital eye strain for spending overtime in front of digital screen. Accommodation anomalies or disabilities may cause due to constant near work focusing and concentration. Myopic progression is also significantly noted due to excess digital screen exposure [8].

In a medical research study conducted by Navid Anwar *et al.* in Lahore in 2020, focusing on the effects of technology overuse among individuals aged

18 to 25 years old, approximately 200 participants were studied over a period of six months. The sample consisted of 50% females. The study revealed that a significant number of participants who used digital screens for approximately 6 to 7 hours continuously experienced myopia. The majority of screen time was dedicated to social networking, suggesting a need to limit such overuse [9].

Furthermore, prolonged use of digital devices can lead to increased glare issues, especially when using small screens on mobile devices, which requires more effort to discern objects from a distance. Factors such as glare, high contrast, screen resolution, excess brightness etc. are responsible for ocular complications and digital eye stress [11].

In a recent study by James S. Wolffsohn *et al.*, published in April 2023, ocular discomfort and eye strain were highlighted as factors that can negatively impact physical health. The study reported that a staggering 97% of computer and Smartphone users suffer from computer vision syndrome. This syndrome is primarily attributed to surface disorders related to a reduced blinking rate while viewing digital screens and surface dryness, which can be exacerbated by long-term use in air-conditioned rooms. Additionally, refractive errors progress rapidly due to prolonged close work with digital devices [11].

Management & Treatment

A research study conducted by Ehan Tal, Collis, Brace, Nunn, *et al.* outlined several factors associated with computer vision syndrome. These include:

- Working at a very close distance to digital screens
- Exposure to digital screens with high brightness
- Viewing very small objects for extended periods
- Engaging in tasks requiring high cognitive function
- Having a low blink rate
- Pre-existing dry eye syndrome
- Prolonged exposure to air conditioning while working on digital devices
- Uncorrected refractive errors
- Abnormalities in accommodation and vergence
- Sleeping disorders or anomalies

Regarding management and treatment, the study recommended symptomatic treatments such as using antipyretics as needed for high fever. Additionally, for uncorrected refractive errors definitely need to correct the refractive errors with spectacles or contact lenses to enhance quality vision improvement [12].

For the vergence dysfunction small heterophoria induced and vision 20-20-20 exercise is effective for the IT professionals or prolongs computer users. For ocular surface dryness and hydration maintaining artificial or additive tears can be advised to reduce the discomfort.

Spectacle with protective like ARC COAT, blue block coating can be helpful for the patients use digital screens for the prolong time daily.

Pencil push up, accommodative flipper exercise, Brock string convergence exercises are also helpful to improve the focusing capabilities with changing distances.

Beside this patient awareness, education, follow up consultation and eye examinations are very needful for protecting ocular health from the excess digital screen exposure [13].

In another study focused on management strategies, it was emphasized that controlling eye stress is contingent upon one's daily lifestyle and habits. Protective eyewear was highlighted as a crucial tool for correcting refractive errors, with special anti-refractive coatings and blue light-blocking lenses recommended to mitigate eye stress during digital screen work. Taking breaks between continuous work sessions emerged as a highly effective method for protecting against eye strain and bolstering focusing capabilities. It was also advised to adjust lighting indirectly to minimize glare, a common contributor to eye strain. Additionally, limiting screen time, particularly under direct sunlight exposure, was encouraged to reduce eye stress. Artificial tears can be helpful to treat dryness condition to supply the proper hydration level to corneal health [13].

Another study highlighted the neurological implications associated with digital eye strain, which can induce additional stress. Patients are advised to educate themselves on maintaining proper posture while using laptop screens, as incorrect positioning can lead to severe pain and headaches. Moreover, factors such as dryness, allergies to cold air, air conditioning, and migraines can exacerbate the stress experienced during digital work. Protective eyewear, contact lenses, artificial tears, and vision exercises were identified as helpful measures for ensuring comfortable computer work by providing protection fields [14].

Prevention

In another study focusing on prevention strategies, adherence to the Vision 2020 rules was emphasized to improve focusing capacity and reduce dryness. Continuous focusing with a low blink rate can lead to increased dryness and eye strain, characterized by burning and tearing sensations. The rule suggests taking a break during constant distance work, focusing on a point 20 meters away for at least 20 seconds every 20 minutes, accompanied by blinking. This practice boosts blink rate, ensuring normal tear secretion and drainage, crucial for maintaining healthy tear films that nourish and hydrate the cornea, supporting proper nutrition and refraction. Additionally, protective eyewear that filters glare and blue light, as well as artificial tears, are recommended. Furthermore, physiotherapy can be beneficial in managing neck pain resulting from prolonged screen time [15].

In a study, it was found that prolonged work on a particular task may lead to digital eye strain if the lighting is either excessively dim or extremely bright. Incorrect posture while viewing a digital screen from an extreme near distance may increase stress. The study recommends keeping the screen at least an arm's length away from the eyes. In the case of prolonged work, enlarging letter size may reduce cognitive strain, making the work more comfortable and less affected by environmental factors such as pollution or heated air, which can increase discomfort and eye tearing. Therefore, it's important to avoid these conditions. Uncorrected refractive errors and non-strabismic anomalies should be addressed with proper vision exercises [16].

Conclusion

Nowadays, due to professional activities, advancements, and modernization, we are increasingly reliant on digital devices for tasks such as calculations and data management. This reliance demands significant accommodative effort, convergence and proper correction to cope with the daily stresses of work. Engaging in prolonged near work with abnormal head positions and excessive brightness during exercise can lead to discomfort and digital eye strain. Proper patient education and awareness about vision checkups, correcting refractive errors, and the importance of using protective eyewear are essential in reducing the percentage of digital eye stress among computer users. However, relying solely on vision exercises during daytime eye treatment with medication may not be effective without preventive steps and could potentially less effective in addressing digital eye stress levels.

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Chapter - 6

Achromatopsia: Literature Review and Case Study

Abstract

Congenital achromatopsia is a rare macular dystrophy affecting one in 30,000 to 50,000 people. It is associated with five genetic markers, with mutations in the CNGA3 and CNGB3 genes responsible for over 90% of cases. The disease presents with colour vision defect, early onset of visual impairment, photophobia, pendular nystagmus, and an abnormal photopic electroretinogram (ERG). The disease has two forms: incomplete, which is milder due to residual cone function, and complete, which is severe due to the complete absence of cone function. The diagnosis of achromatopsia has been challenging due to the variability in clinical presentations and associated symptoms. The advent of spectral domain optical coherence tomography (SD-OCT) has revolutionized the evaluation and understanding of achromatopsia.

Achromatopsia is a rare macular dystrophy with variable presentation, presenting with a range of symptoms including reduced vision, photophobia, dyschromatopsia, and nystagmus. Diagnostic tests like SD-OCT, fundus autofluorescence, and electrophysiology aid in ruling out distinct aetiologies. Traditional diagnostic methods, such as diminished light-adapted flash photopic ERG and 30 Hz flicker, have been used to diagnose achromatopsia. Recent diagnostic modalities, like SD-OCT, have helped in evaluating achromatopsia, providing a better understanding of the disease. The use of SD-OCT has helped document a progressive degenerative process noted with increased age, with a flattened appearance of the cystic area on OCT. Animal genetic studies have further collaborated on the progressive nature of the disease, with a CNGA3 genetic mutation contributing to the progressive form of the disease.

Achromatopsia is a rare macular dystrophy with variable presentation, presenting with vision reduction, photophobia, dyschromatopsia, and nystagmus. Diagnosis traditionally involves a diminished light-adapted flash photopic ERG and 30 Hz flicker, which correlate with the functional loss of cone photoreceptors. Recent diagnostic modalities like SD-OCT have helped in evaluating achromatopsia, giving a better understanding of the disease.

Congenital achromatopsia, also known as rod monochromatism, affects one in 30,000 to 50,000 people and is associated with five genetic markers. The disease presents with color vision defects, early visual impairment, photophobia, pendular nystagmus, and abnormal photopic electroretinograms. SD-OCT can help visualize characteristic morphological alterations linked to achromatopsia, aiding in diagnosis and potentially enhancing future therapeutic alternatives.

Introduction

Macular dystrophy is a condition that is linked with a malfunction or lack of cone photoreceptors. Congenital achromatopsia, which is also known as rod monochromatism, is such a condition. A uncommon form of macular degeneration affects about one in 30,000 and 50,000 people. As of right now, there are five genetic markers that are connected to this heterogeneous autosomal recessive cone dystrophy. The capacity of cone photoreceptors to respond to a light stimulus is impaired when there is a mutation in the gene that causes this malfunction. The CNGA3, CNGB3, GNAT2, PDE6H, and PDE6C genes are among the known related gene mutations that are responsible for more than ninety percent of the instances with achromatopsia. It has been found that the most prevalent mutations are those that occur on the CNGA3 and CNGB3 genes.8 Due to the fact that the condition is caused by different genotypes, there is a great deal of variation in the clinical presentation of achromatopsia. The literature does not provide a lot of evidence to support the hypothesis that there is a correlation between a certain genotype and phenotypic expression.

Discussion

The traditional clinical presentation of achromatopsia involves a loss in colour vision, the beginning of visual impairment at an early age, photophobia, pendular nystagmus, and an aberrant electroretinogram (ERG) of the photopic region of the retina. There are two types of the condition, which may be distinguished from one another based on the frequency and severity of cone malfunction. The incomplete form is linked to a sort of visual impairment that is less severe since it is connected with residual cone function. As a consequence of the total lack of any cone function, the full form is distinguished by a significant vision impairment that can range anywhere from 6/30 to 26/120.9,11

Despite the fact that there may be no indication of maculopathy already present, clinical ophthalmoscopic findings might range from a simple loss of foveal reflex to the more traditional confined maculopathy. There is a

significant amount of variation in clinical presentations and related symptoms, which contributes to the difficulty of diagnosis.

To verify the diagnosis, supplementary testing, such as photopic electroencephalograms, has been utilised for a considerable amount of time. Functional assessment was corroborated by a significant drop in response to the 30 Hz flicker, which was attributed to a malfunction of the cones. On the other hand, structural evaluation of the illness was restricted to histology studies that revealed the lack of foveal cone photoreceptors or their distortion.

The assessment and comprehension of achromatopsia have been completely transformed as a result of the introduction of spectral domain optical coherence tomography (SD-OCT), which has the capacity to clearly identify the inner segment/outer segment (IS/OS) junction. There is a structural correlation between the defective cones and the lack of the subfoveal insulin-secretion system junction. The typical hyporeflective 'punched out' subfoveal zone on optical coherence tomography (OCT) can lead to the diagnosis of achromatopsia even when only modest ophthalmological symptoms are present. This zone correlates to the absence of the IS/OS junction. Recent discussions in the academic literature have brought up these findings, which have not been without their share of dispute.

During the course of a case study, a Hispanic guy who was 24 years old appeared with complaints of photophobia and reduced vision that had been present for a long time. He denied that he had ever had nyctalopia or a limitation in his vision field. His medical background was not very noteworthy. Since an early age, the patient has been diagnosed with a vision impairment of uncertain aetiology, according to their previous ocular history. His family history indicated that his maternal aunt had maculopathy, which was likewise linked with diminished visual acuity and had a congenital origin. However, there was no recognised diagnosis for the ailment because it was not diagnosed until much later.

According to the modified Early Treatment Diabetic Retinopathy Study (mETDRS), the visual acuity of both the right and left eye was equal to 6/36. The manifest refraction of the right eye was -3.75–2.50 × 045, and the left eye was -6.25–1.50 × 135. Additionally, there was no afferent pupil defect in either eye, and the pupils were circular and receptive to light in equal measure. There were so many people on the confrontation fields that it was impossible to count them all. In every single look, the extraocular muscles of both eyes were completely free. While the contralateral eye was occluded, the right and left eyes exhibited a little horizontal nystagmus in primary gaze. This was seen in both right and left eyes. A significant colour vision impairment was

discovered through the use of the Hardy Rand and Ritter 4th Edition Pseudoisochromatic plates for colour vision testing. As a consequence, the individual was unable to enjoy any colour vision with either eye. Additional colour vision testing with both saturated and desaturated Farnsworth D-15 found that there was no colour discrimination at all, and there was also no colour defect pattern connected with it.

Examination with a slitlamp revealed nothing unusual. Using Goldmann tonometry, the intraocular pressures were measured to be 12 mmHg on both R and L. During the dilated fundus examination, both eyes were found to have pink optic nerves that were different from one another and had cup-to-disc ratios of 0.3/0.3. Both eyes had an artery to vein ratio of two thirds, which indicated that the retinal vasculature seemed to be normal. Clarity was observed in the vitreous of both eyes. It was observed that the macula of both eyes had a little disturbance in the retinal pigment level. In both cases, the peripheral retinae were not notable.

The results of the SD-OCT showed that both eyes had blunt foveal contours that were symmetrical and linked with macular thinning. According to Figure 2, there were sub-foveal hyporeflective flattened 'punched out' zones in both eyes. These zones were connected with a missing IS/OS connection. Both the light-adapted whole field ERG and the 30 Hz flicker experiments showed that there was no response to the photopic stimulus, and the amplitudes of the 30 Hz flicker experiment were almost undetectable. It was determined that the patient had total achromatopsia according to the findings of the clinical examination and the auxiliary tests.

Counselling was provided to the patient on the diagnosis. However, several low vision aids were demonstrated to the patient, and the patient had a positive response to several devices, such as a Specwell 8D monocular telescope to assist in distance identification and an Optelec Compact + for near work. After the patient reported that he felt satisfied with his ability to function in his day-to-day activities, he was shown several low vision aids. A reading device, specifically an Apple iPad and an Amazon Kindle, was also presented to the patient. An Apple iPhone was already in the possession of the patient, and they were already aware with the different tools and programmes that are available to assist patients who have limited vision. Several different lens filters were demonstrated to the patient in order to alleviate the photophobia that he was experiencing. Because the patient believed that he did not require any devices at this time, no lenses or devices were issued to him (with the exception of an updated correction for his spectacles). The progression of the patient is being monitored on a yearly basis through this process.

The diverse appearance of achromatopsia, which is an uncommon form of macular dystrophy, is one of the factors that adds to the difficulty of diagnosis. The condition known as achromatopsia can manifest itself with a wide variety of symptoms, such as a loss in vision of varied degrees, photophobia, dyschromatopsia, and the presence or absence of nystagmus. A long-standing history of visual impairment, together with accompanying photophobia, was shown by our patient. Additionally, the clinical appearance might range from a loss of foveal reflex to a maculopathy that is later in its progression. The macular disturbance that our patient exhibited was fairly mild and bilaterally symmetrical. The fact that the structural alterations in individuals with achromatopsia frequently do not coincide with the functional changes 9,11,14 is another factor that contributes to the difficulty of the diagnostic process. Stargardt's disease, hypoplastic fovea associated with ocular albinism, inverse retinitis pigmentosa, and Best's disease are some of the differential diagnoses that can be made for early-onset maculopathies that are associated with visual impairment. Vitreomacular traction, early age-related macular degeneration, drug-related maculopathies (plaquenil or tamoxifen macular toxicity), lamellar hole, idiopathic macular hole, and solar maculopathies are some of the conditions that can be included in the differential diagnosis of acquired maculopathies in adult patients who have visual impairment. These additional disorders are distinct from achromatopsia in a variety of aspects, including the start of symptoms, clinical presentation, and results on optical coherence examination (OCT). The use of diagnostic procedures, including as fundus autofluorescence, electrophysiology, and SD-OCT, help in the process of eliminating different aetiologies. This is in addition to the rigorous and extensive eye examination that is performed. A comprehensive case history can be helpful in eliminating a number of potential causes, such as medication toxicity. If a patient has Stargardt's disease, fundus autofluorescence can be used to confirm the distinctive general rise in autofluorescence that is associated with the condition. The diagnosis of inverse retinitis pigmentosa, on the other hand, is validated by electrophysiological testing that reveals a dampened scotopic electroretinogram (ERG). These maculopathies, which include vitreomacular traction, lamellar hole, and solar maculopathies, may be easily verified with the use of SD-OCT. This is due to the fact that each of these maculopathies has its own unique SD-OCT results. In contrast to the morphological results that are linked with congenital achromatopsia, these findings are different.

A reduced light-adapted flash photopic ERG and a 30 Hz flicker have traditionally been utilised in the diagnostic process for achromatopsia since its inception. With the functional loss of the cone photoreceptors, there is a

correlation between the diminished flash photopic ERG and the 30 Hz flicker activity. A flash photopic electroencephalogram (ERG) of our patient revealed that there were no A, B, or C waves present, and there was a flicker response of 30 Hz that was almost impossible to detect.

The examination of achromatopsia has been assisted by more contemporary diagnostic methods, such as the SD-OCT, which has resulted in a better knowledge of the condition. It would appear that the SD-OCT is able to distinguish the structural alterations that are linked with the loss of cone photoreceptors subfoveally. Patients diagnosed with achromatopsia have subfoveal disruption of some kind at the level of the interocular space (IS) and the outer layer of the retina (OS), and in more advanced cases, retinal pigment epithelium atrophy.

SD-OCT pictures were analysed by Thiadens and colleagues9 in forty individuals who were diagnosed with achromatopsia. In the research, the standard OCT result was described. This finding featured a subfoveal hyporeflective 'punched out' zone that was coupled with an intact hyper-reflective external limiting membrane and the underlying retinal pigment epithelium. It has been found that the lack of the IS/OS junction is correlated with the hyporeflective zone. In addition to the thinning of the outer nuclear retinal layer, other findings associated with achromatopsia include a change in the foveal contour, a reduction in the foveal depth, and overall thinning of the retina.12 The variability in SD-OCT findings may contribute to the overall distinct fundoscopic presentations that are associated with achromatopsia.

Thomas and his colleagues12 made a significant contribution to the expansion of our knowledge of the disease by establishing a connection between the pathophysiology of the disorder and a specific SD-OCT appearance. The foveal contour changes that were observed within the SD-OCT were thought to be correlated with the classic 'punched out' zone that was also observed on the SD-OCT. This was attributed to structural change that occurred as a result of progressive age-related dysfunction of the cone photoreceptors.12 Furthermore, they believed that the progressive cone degeneration that was observed in patients with achromatopsia could be attributed to the loss of phagocytotic activity at the level of the retinal pigment epithelium. With the passage of time, this appears to grow increasingly apparent.12

In the past, achromatopsia was considered to be stable and non-progressive. However, the use of SD-OCT has assisted in the documentation of a progressive degenerative process that is observed with increasing age.9–

10 Genead and colleagues14 investigated SD-OCT findings in individuals with achromatopsia who were of varying ages. According to what they observed, the traditional SD-OCT finding does not appear to be present among younger individuals. Their study revealed that only 17 per cent of patients under the age of nine presented with the classic SD-OCT findings, while all patients over the age of 40 displayed the classic OCT finding associated with the hyporeflective subfoveal 'punched out' zone of the missing IS/OS junction.14 The use of the SD-OCT further documents a change in the classic finding, whereby a flattened appearance of the 'punched out' cystic area on OCT is noted with an increase in age.9,13 The flattening or disappearance of the cystic hyporeflective space correlates to overlying retinal layers merging with the retinal pigment epithelium.9 Although our patient was only 24 years of age, the SD-OCT revealed a more flattened cystic-like space associated with a missing subfoveal IS/OS junction. This conclusion is consistent with the findings of earlier investigations and the hypothesis that the illness exhibits a progressive character. The findings of the progressive SD-OCT and the link between those findings and the age of the patient have been the subject of significant debate. After evaluating forty individuals who had achromatopsia, Sundaram and colleagues11 discovered that there was no association between the age of the individual and the SD-OCT results that were related with it. The authors did not deny the progressive character of the ailment; rather, they hypothesised that the absence of an IS/OS zone was not connected to the phenotypic expression of the patient or to the patient's age. There is a possibility that future longitudinal research will give more demonstrable data in relation to this dispute. Despite the fact that there are no studies conducted on humans, genetic research conducted on animals has further contributed to the observation that the disease is progressive. The CNGA3 genetic mutation was found to be a contributor to the progressive form of the disease, according to a study that examined the retinas of knockout mice, which are mice that do not have cone-specific channels.15 Histological examination of the retina of these young mice revealed that only 10 to 20 percent of their cones were functional, whereas the retina of the older mice had complete degeneration of all of their cones.

When it comes to macular dystrophy, achromatopsia is an uncommon condition that can appear in a variety of ways, which adds to the difficulty of diagnosis. A variety of symptoms, including a decrease in vision, photophobia, dyschromatopsia, and the presence or absence of nystagmus, may be present in patients with this condition. It is possible for the clinical appearance to range from a loss of foveal reflex to more severe maculopathy, with mild bilateral symmetrical macular disruption appearing in some cases.

There is frequently no correlation between structural abnormalities and functional changes, which makes diagnosis even more challenging. Stargardt's disease, hypoplastic fovea associated with ocular albinism, inverse retinitis pigmentosa, and Best's disease are some of the differential diagnoses that can be made for early-onset maculopathies that are associated with visual impairment. Vitreomacular traction, early age-related macular degeneration, drug-related maculopathies (plaquenil or tamoxifen macular toxicity), lamellar hole, idiopathic macular hole, and solar maculopathies are some of the conditions that can be included in the differential diagnosis of acquired maculopathies in adult patients who have visual impairment.

A reduced light-adapted flash photopic ERG and 30 Hz flicker are generally taken into consideration when making a diagnosis of achromatopsia. These two characteristics are associated with the functional loss of cone photoreceptors. On the other hand, more contemporary diagnostic techniques such as SD-OCT have allowed for the evaluation of achromatopsia, which has resulted in a better knowledge of the condition. In the subfoveal region, the SD-OCT appears to be able to distinguish structural alterations that are related with the loss of cone photoreceptors. Patients diagnosed with achromatopsia have subfoveal disruption of some kind at the level of the interocular space (IS) and the outer layer of the retina (OS), and in more advanced cases, retinal pigment epithelium atrophy.

The pathophysiology of the condition has been linked to a specific SD-OCT presentation, with foveal contour alterations found within the SD-OCT connected with the IS/OS typical 'punched out' zone. This has been the case since the ailment became apparent. It is possible that the decrease of phagocytotic activity at the level of retinal pigment epithelium is responsible for the progressive cone degeneration that is seen in individuals who have achromatopsia.

The findings of SD-OCT have contributed to the documentation of a gradual degenerative process that is observed with increasing age. On the other hand, there has been debate over the findings of the progressive SD-OCT and the connections between those findings and the age of the patient. In addition, animal genetic studies have been conducted in order to better investigate the progressive aspect of the disease. For example, a research conducted on the retinas of knockout mice revealed that a genetic mutation known as CNGA3 was responsible for the progressive form of the disease.

This unusual form of macular dystrophy is characterised by the malfunction or lack of cone photoreceptors. Congenital achromatopsia, which

is also known as rod monochromatism, is another name for this condition. In addition to being linked to five genetic markers, it affects between one in 30,000 and 50,000 persons nationwide. Mutations in genes are responsible for more than ninety percent of instances, with the genes CNGA3, CNGB3, GNAT2, PDE6H, and PDE6C being the most prevalent candidates. A number of symptoms, including colour vision deficits, early visual impairment, photophobia, pendular nystagmus, and aberrant photopic electroretinograms, are commonly associated with this condition. Incomplete forms of the illness are characterised by a less severe visual impairment, whereas complete forms of the disease are characterised by a more progressive visual impairment. The results of a clinical ophthalmoscopic examination might range from a lack of foveal reflex to confined maculopathy. Due to the fact that dysfunctional cones are correlated with the lack of the subfoveal IS/OS junction, the introduction of spectral domain optical coherence tomography (SD-OCT) has brought about a revolution in the evaluation and comprehension of achromatopsia. These findings have been investigated in the research literature, and they have been met with some degree of debate.

In the course of a case study, it was observed that a Hispanic guy, aged 24, who had been experiencing photophobia and impaired vision for a considerable amount of time appeared without any previous history of nyctalopia or visual field limitation. His family history indicated that his maternal aunt had maculopathy, which likewise had a congenital origin and was linked with diminished visual acuity. His medical history was ordinary, but his family history presented a concern. On the modified Early Treatment Diabetic Retinopathy Study (mETDRS), the patient's visual acuity was measured at 6/36, and a little horizontal nystagmus was seen in primary gaze. Through the use of colour vision tests, it was discovered that the individual had a significant colour vision deficiency, which led to the inability to enjoy any colour vision with either eye. During the dilated fundus examination, the optic nerves were found to be pink and distinct, and the vasculature of the retina looked to be normal. The results of the SD-OCT showed that there were bilateral symmetrical blunt foveal contours, linked with macular thinning, sub-foveal hypo reflective flattened 'punched out' zones, and a missing IS/OS junction. The diagnosis of total achromatopsia was made after the light-adapted whole field ERG and the 30 Hz flicker showed that there was no response to the photopic stimulation of the patient. The patient was counselled on the diagnosis and shown different low vision devices, such as a Specwell 8D monocular telescope for identifying distances and an Optelec Compact + for working in close proximity to objects. In an effort to alleviate his photophobia, he was presented with a variety of lens filters; however, no

equipment or lenses were provided to him. The progression of the patient is being monitored on a yearly basis through this process.

Conclusion

It is important to note that this particular case is a typical example of congenital achromatopsia, which highlights the diagnostic relevance and benefits of an SD-OCT. Due to the fact that achromatopsia can manifest in a variety of ways, the diagnosis of the condition can be difficult. Visualising the typical morphological changes that are associated with achromatopsia may be accomplished through the use of SD-OCT, which can thus be of assistance in the diagnosing process. Having a better understanding of achromatopsia might potentially lead to improvements in the therapy options available in the future. It is possible that the use of SD-OCT might be of critical importance in the timely detection of achromatopsia during its first phases, as well as in the identification of people who can possibly benefit from upcoming treatment options. In addition, the changes in structure that are seen on spectral domain optical coherence tomography (SD-OCT) can be employed to monitor the progression of the illness being studied.

The subjective and objective parameters of SD-OCT can be utilised, in a manner analogous to that of other retinal illnesses, in order to evaluate the efficacy of proposed treatment strategies for persons who have achromatopsia.

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Chapter - 7

Prevalence of Untreated Matured Cataract in Rural and Urban Areas

Abstract

Objective: To find out prevalence of untreated matured cataract and also finding figure percentage about immature cataract and association with systemic disorders.

Method: Around 1000 patient screening conducted and data collected for clinical study purpose from 300 camps within 2 years (2021-2022). The detailed information including the demographic data, social history and medical history was collected. The intensity of the disease was diagnosed with respect to the severity of lens opacity and decreasing visual acuity due to cataract formation.

Findings: Clinical examinations like visual acuity assessment, torch light examination performed at camps for the concerned problems. On the basis of the examination, the cataract problems were graded in respect of the opacity. It was seen that most of the patients suffering from cataract with acute clinical condition. Most of the patients suffering due to senile cataract & age-related changes. Besides this, other systemic condition like diabetes, hypertension, smocking, etc. are also responsible for this. It is found that most of the cataract patients (70%) as untreated and undiagnosed without any previous diagnosis and medical history. On the other hand, the patients came for screening with previous medical history is very low numbers estimated as 30%. Out of 70% of undiagnosed cataract patients, the number of immature cataract patients and mature cataract patients found as 30% and 40% respectively. 20% of total undiagnosed cataract patients were suffering from other systematic diseases along with cataract. The total number of only immature cataract patients found as 20% and total number of only matured cataract patients estimated as 30%.

Conclusion: As far as the findings were concerned, most of the patients suffering from cataract especially of matured type from rural areas. It was because their lack of awareness & education. The urban people, on the other hand, came to be treated as immature cataract patients. It says regarding their

knowledge and consciousness. Lack of consciousness makes the rural people untreated in spite of being affected by cataract. Hence, most of them were affected by matured type of cataract. Finally, it is concluded that ageing, alcoholic addiction, diabetes, hypertension, socio-economic status and self-awareness are the prominent factors to be considered as risk factors causing eye problems in relation to cataract.

Keywords: Prevalence of untreated cataract, cataract, cataract in rural and urban area

Introduction

Most of the patients these days who are coming for the treatment for blindness are affected by cataract. It is so common in today's society that it seems to be the salient feature of current period of time. The no. of cataract patients is increasing day by day at alarming speed. According to the WHO, globally cataract causes blindness by 17% at least accounting for 94 million visions impaired people. In the case of India, 80.1% of blindness is caused for cataracts. Of course, other systemic diseases like diabetes, hypertension, and other activities like smoking and alcohol addiction and some factors like ignorance, lack of self-awareness, socio-economic status, use of drugs and advancement of age lead to get affected by cataract. Especially most of the patients are victims of cataract problem for their age growth [1, 2, 3, 4, 5, 6].

Classification

Generally, 3 kinds of cataract in respect of grades are there. They are as,

i) Early stage or Grade I
ii) Moderate stage or Grade II
iii) Advanced stage or Grade III

Based upon the maturity of cataract generally they are of 3 kinds; as

1) **Immature Senile Cataract (ISC):** In case of immature senile cataract, the lens is partially opaque. In this opacification progresses further the lens appears grayish white but clear cortex is still present and iris shadow is visible.

2) **Matured Senile Cataract (MSC):** If the lens of the completely opaque, we call it matured cataract. Lens looks pearly white. When opacification is completed and the cortex is involved in full, it is named MSC.

3) **Hyper Matured Senile Cataract (HMSC):** It is caused due to the leakage of water from the lens. The state of hyper maturity begins when mature cataract is left in situ. Generally, this kind of cataract is

seen in two forms, such as Morgagnian HMSC and Sclerotic HMSC [8, 9, 10, 12].

Mechanism of lens of transparency

The mechanism of transparency loss varies in nuclear and cortical senile cataract [10, 12].

Cortical senile cataract

This kind of cataract is primarily typified with some biochemical feature as:

- Decreased levels in the crystalline lens of total proteins
- Amino acids and potassium related with increased concentration of sodium.
- Marked by hydration of the lens followed by coagulation of lens proteins

Nuclear Senile Cataract

The features of this kind of cataract can be described as bellow:

- Intensification of the nuclear sclerosis due to growth of age.
- Dehydration and compaction of nucleus.
- It is a hard cataract for the above degenerative changes.
- It goes with an increase in water insoluble proteins.
- The total protein content remains normal.

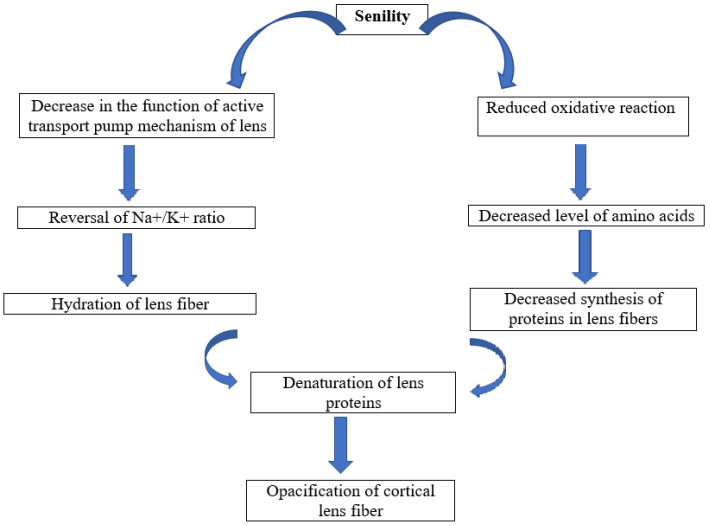

Fig 1:

Flow chart (figure 1) describes mechanism of loss of transparency in case of cortical senile cataract

Literature review

As far as the victimization of cataract in case of the rural villages was concerned, it was 47.5% and the affected age group was the people more than 40 y/o. It was the result of the study made by Nirmaln et.al. His study says that the women are more susceptible to cataract than the male folk in southern India [19]. As per the report of Vashist *et al.* the prevalence of cataract in Northern India and in Southern India was 58% and 53% respectively in connection with the people of older age group (more than 60 y/o) in recent years. This report emphatically says about the nuclear cataract to be the cataract of a common type [7]. Undoubtedly, the numbers of cataract patients is increasing very rapidly, maintaining a pace with material success. Aging has been considered as a primary risk factor of cataract. The no. of patients being affected by cataract was 60% i.e., 56 million in 1991 and it has been estimated to be doubled by 2016 [20]. However, the present study aims at identifying the cataract patients in proportion to their age limit, gender, and their habitats (living places) indicating whether urban or rural. The patients are also to be evaluated in respect of whether they are educated or illiterate, conscious or ignorant regarding the importance of eye.

Methods

Since last 2-3 years so many eye camps were organized by both different voluntary organizations and on behalf of our university in connection with the treatment of the patients suffering from eye cataract in both rural and urban areas. This is on the basis of the information shared with the patients in respect of different clusters consisting of about 1000 people. In the districts like Khordha, Cuttack and Puri of Odisha the camps were organized with the duration of one day. It can be stated that a minimum 80 patients came to be treated for their eye problems in each of the camps. Out of the total no. of patients it was seen that majority of them suffered from matured cataract on account of their negligence and lack of medical facility nearby. It seemed that the camps organized in rural countryside regions were meant to treat the patients with matured untreated cataract patients belonging to the farmer families. The ratio of the women patients was higher than that of the men. It can be concluded that the women are more neglected than men folk in rural based farmers families.

The whole treatment was conducted on the basis of determining Visual Acuity, Torch Light examination. Although cataract is a very common

problem affecting the eyesight of the people, about 20% of the patients were affected by both cataract problems and other diseases such as diabetes, hypertension, etc.

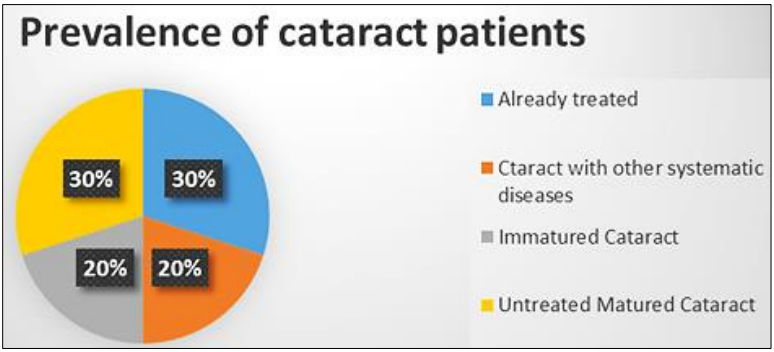

Fig 2:

Shows the prevalence of cataract in rural urban areas of the districts of Odisha have been mentioned above. 30% of total cataract patients had come after treatment, and 70% came for treatment for the 1st time without any previous medical history. 20% of total untreated cataract suffered from other systemic diseases along with cataract. The total no of only immature cataract patients was 20% and total no of only matured cataract patients was 30%.

It was seen that most of the patients suffering from cataract use to face acute eye problem. Most of the patients suffering from cataract due to ageing. Besides this, other reasons like diabetes, hypertension, smoking, etc. are responsible for this. It was seen that most of the cataract patients (70%) came for the 1st time for treatment without any previous medical history. On the other hand, the no. of patients that came for treatment with previous medical history is very low i.e., 30%. Out of 70% of untreated cataract patients, the no. of immature cataract patients and mature cataract patients in respect with the duration of period for which the patient has suffered was 30% and 40% respectively. 20% of total untreated cataract suffered from other systemic diseases along with cataract. The total no of only immature cataract patients was 20% and total no of only matured cataract patients was 30% [18].

Findings

Different examinations for the concerned problems were made like Visual Acuity examination, torch Light examination. On the basis of the examination, the cataract problems were graded in respect of the opacity. It was seen that most of the patients suffering from cataract use to face acute eye problem. Most of the patients suffering from cataract due to ageing. Besides this, other

reasons like diabetes, hypertension, smocking, etc. are responsible for this. It was seen that most of the cataract patients (70%) came for the 1st time for treatment without any previous medical history. On the other hand, the no. of patients that came for treatment with previous medical history is very low i.e., 30%. Out of 70% of untreated cataract patients, the no. of immature cataract patients and mature cataract patients in respect with the duration of period for which the patient has suffered was 30% and 40% respectively. 20% of total untreated cataract suffered from other systemic diseases along with cataract. The total no of only immature cataract patients was 20% and total no of only matured cataract patients was 30%.

Discussion

As far as the findings were concerned, most of the patients suffering from cataract, especially those of matured type, belong to rural areas. It is because of their lack of education and ignorance. The urban people, on the other hand, came to be treated as immature cataract patients. It says regarding their knowledge and consciousness. Lack of consciousness makes the rural people untreated in spite of being affected by cataract. Hence, most of them were affected by a matured type of cataract. Finally, it is concluded that growth of age, alcoholic addiction, diabetes, hypertension, socio-economic status and self-awareness are the prominent factors to be considered as risk factors causing eye problems in relation to cataract [16, 17].

Preventive measures

As we all need to be protected from cataracts, we need to keep certain points in our mind. First of all, we are required to protect our eyes from ultra violet (UV) rays by using sunglasses in the outdoor world. Regular eye examination by the reputed physicians can protect us from cataract problems. Smoking and alcoholic intake are to be avoided to keep our eyes strong, healthy and fine. Besides these, we need to eat fruits and vegetables with antioxidants properties and proper nutrients. In case of diabatic patients, they are hereby advised to consult with the concerned doctors from time to time in a regular interval [13, 14, 15].

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Chapter - 8

Role of Atropine in Progressive Myopia

Abstract

Myopia, also known as ‘Near-sightedness’, is the one of the most common refractive diseases worldwide, and its prevalence is likely to rapidly increase in the near future. Its onset usually occurs during childhood and it is caused by an excessive axial elongation of the eyes. It has become a significant global concern due to its rising prevalence and associated ocular health risks. Atropine, a muscarinic antagonist traditionally used for its mydriatic and cycloplegic effects, has recently garnered attention for its potential in managing progressive myopia. This abstract reviews current literature to explore the mechanisms underlying atropine's efficacy, its optimal dosage regimens, and its impact on controlling myopia progression. Several studies indicate that atropine exerts its anti-myopic effects by inhibiting the action of acetylcholine at the ciliary muscle and modulating scleral proteoglycan synthesis, thereby reducing axial elongation. Recent clinical trials, such as the ATOM (Atropine in the Treatment of Myopia) studies, have demonstrated the effectiveness of low-dose atropine (0.01% concentration) in slowing myopia progression with minimal side effects. However, higher concentrations (0.1% to 0.5%) have shown superior efficacy, albeit with increased risk of transient photophobia and near vision disturbances. Furthermore, the duration of atropine treatment remains a subject of debate, with prolonged use potentially necessitating ongoing monitoring for adverse effects, particularly in pediatric populations. Nevertheless, the overall benefits of atropine in reducing myopia progression, coupled with its relatively favorable safety profile at lower concentrations, underscore its potential as a valuable therapeutic option. In conclusion, while further research is warranted to optimize treatment protocols and elucidate long-term outcomes, atropine emerges as a promising pharmacological intervention for managing progressive myopia. Its integration into clinical practice holds promise for addressing the growing global burden of myopia-related complications and improving ocular health outcomes in affected individuals.

Introduction

Myopia, commonly known as near-sightedness, is a prevalent refractive error affecting a significant portion of the global population. The most common refractive error is Myopia, become a worldwide leading cause of blindness.

Also, it has been predicted that one in every two children will become myopic by the year 2050, which is an increase of nearly 50% worldwide.

Increasing myopia worldwide is associated with retinal detachment, early-onset glaucoma, cataracts [3], macular degeneration & finally vision loss [4]. Also, recent estimate projects showed that almost 5 billion world population will suffer from myopia by the year 2050 [5, 2].

Also, the progression of myopia has an impact not just on ocular health but also it can resist our quality lifestyle, global economy, psychological health, education, etc. Generally, in the times of childhood to school age, the progress the myopia in the patients & can gradually stabilize after the time of adolescence for most individuals. The progression of myopia in school-going children catalyzes some factors such as near work [6], longer time spent indoors [7], prolonged intense education [8] & urbanization [9, 5, 10, 11, 12].

Progressive myopia, characterized by the elongation of the eyeball and resultant refractive error, poses a significant public health concern worldwide due to its rising prevalence and associated ocular complications, also an increase in the vitreous chamber depth of the eyes, light from distant objects can focus in front of the retina, that cause the formation of blurred images. In progressive myopia mismatches between the focal length of the eye & axial length of the eye in myopia, cause the refractive power of the lens & cornea [2, 13].

Atropine is an anticholinergic blocking agent, that is mostly effective in myopia control. At low concentrations, atropine has been shown safe & effective in decreasing the progression of myopia in Children of the Chinese community [14, 15, 16]. Basically, in our field, atropine is utilized to induce mydriasis and cycloplegia. This occurs through its action of inhibiting the contraction of the circular pupillary sphincter muscle, which is typically stimulated by the release of acetylcholine. Consequently, the radial iris dilator muscle is allowed to contract, resulting in pupil dilation [17].

Among the various treatment modalities explored for myopia control, atropine has emerged as a promising pharmacological agent capable of slowing the progression of myopia. Atropine, a naturally occurring alkaloid

derived from the deadly nightshade plant (Atropa belladonna), acts as a non-selective antagonist of muscarinic acetylcholine receptors (mAChRs). Its use in ophthalmology dates back to the 19th century when it was initially employed for its mydriatic and cycloplegic effects in diagnostic and therapeutic procedures [17].

The rationale behind the use of atropine in myopia control stems from its ability to inhibit the excessive axial elongation of the eyeball, which is a hallmark feature of progressive myopia. Axial elongation is primarily driven by the dysregulation of scleral remodeling processes, whereby increased scleral extensibility facilitates the stretching and thinning of the scleral tissue, leading to axial elongation and subsequent myopia progression.

The efficacy of atropine in myopia control has been substantiated by a growing body of clinical evidence, with numerous randomized controlled trials (RCTs) demonstrating its ability to slow the progression of myopia in children and adolescents. Uses of atropine have some toxic effects, whose severity of the symptoms varies from mild to moderate to severe depending upon how we can apply by dose, termed this toxicity in clinically "Belladonna poisoning" [17].

Definition of progressive myopia:

Progressive myopia is defined as more advanced than a simple visual disorder. Myopia is a visual disorder better known as near-sightedness. Historically, there has been a fine line between the classification of myopia and high myopia with very little guidance from the ophthalmic community or literature. A prevalence-based definition was introduced by the World Health Organization in 1985, stating that individuals aged between 7-40 years with a spherical equivalent of less than -0.50D are deemed to be myopic. This definition does not consider the severity of myopia as the range includes simple myopia up to cases of severe myopia. Furthermore, there are no recommendations for the elderly onset of myopia, a scenario that is becoming more common due to people living longer and increased achievement in education. Thus, this definition is becoming outdated. High myopia has been classified by the WHO as a refractive error of less than -5.00D. However, this again does not indicate as to the impact of high myopia on ocular health. Shoemaker and Scott produced a definition for pathologic myopia that looks broadly at the posture and development of myopia as well as the ocular complications. This is useful because it identifies the type of myopia we are trying to prevent or lessen, and Horton and Jones have given a detailed definition of progressive myopia. They suggest it is myopia that is no longer controllable with accommodation and it is visually or physically progressive

in the absence of any other ocular disease or surgery. Visual progression is indicated by changes in spectacle corrections, increases in myopia of more than 0.50D, posterior ocular changes, retinal detachment, and Chori retinal degeneration. This is the most useful current definition, and because it is the type of myopia that affects the quality of life and ocular health that is the subject of current research, it is the definition that this discussion will adopt.

Atropine

Since 1960, atropine eye drops have been utilized to slow down the advancement of myopia [18]. Atropine, a naturally occurring alkaloid derived from the deadly nightshade plant, Atropa belladonna, belongs to the class of anticholinergic drugs. Its pharmacological effects are primarily mediated through the inhibition of muscarinic acetylcholine receptors (mAChRs). By blocking these receptors, atropine disrupts the parasympathetic nervous system's activity, leading to various physiological responses. Anticholinergics, a category of pharmaceuticals, inhibit the effects of acetylcholine on muscarinic receptors (MRs) located on tissues innervated by the parasympathetic nervous system and smooth muscle cells. Acetylcholine serves a pivotal role in retinal development and governs ocular growth.

The prevailing hypothesis suggests that atropine functions by inhibiting the signaling pathway responsible for axial elongation, likely through modulation of both M1 and M4 muscarinic receptor pathways. Muscarinic receptors (MRs) are distributed throughout various ocular structures, including the cornea, iris, ciliary muscle [19], lens epithelium [20], retina, retinal pigment epithelium [21], choroid, and sclera (specifically in scleral fibroblasts) [22].

Regrettably, the administration of atropine is linked with various ocular side effects including pupil dilation (mydriasis), sensitivity to light (photophobia), glare, tachycardia, localized allergic reactions, loss of near vision due to paralysis of the ciliary muscle (cycloplegia), irritability or delirium, dryness of mouth, restlessness, and accommodation. These adverse reactions tend to diminish over time upon discontinuation of atropine therapy. The incidence and severity of these side effects appear to increase with higher concentrations of atropine and exhibit a dose-dependent relationship. So, the reason for photophobia in school-going children is associated with blurring vision, resulting in dropout from the study at the largest number [24, 25].

The pathophysiology of myopia involves a complex interplay among genetic, environmental, and behavioural factors. However, the fundamental mechanism revolves around abnormal elongation of the eyeball, resulting in a mismatch between the optical power of the cornea and the axial length of the

eye. This elongation leads to the focal point of light falling in front of the retina rather than directly on it, causing blurred vision.

The two reasons why atropine may have different efficacy in the Indian human eye [18]

1) Atropine acts as a competitive antagonist at muscarinic acetylcholine receptors spanning types M1 to M5. The density and distribution of these receptors exhibit significant variation across eyes with different pigmentation. Each subtype of muscarinic acetylcholine receptor (mAChR), such as mAChR 1 (M1), demonstrates notable genetic polymorphisms.

2) Previous researchers have noted variations in the cycloplegic effects of atropine among different individuals. This variability has been linked to factors such as ethnoracial distinctions, enzymatic variations, and the presence of an "atypical muscarinic receptor" in darker-pigmented eyes. A key contributor to the diverse effects of atropine in various eyes is the variance in drug distribution, as determined by standard radioligand binding techniques. The higher melanin content in darkly pigmented eyes leads to increased nonspecific binding, reducing the bioavailability of these medications to their intended receptors. Consequently, individuals with light-colored irises typically experience satisfactory and swift dilation with cycloplegic-mydriatic drugs over short durations. Conversely, individuals with dark-colored irises may encounter differing outcomes with cycloplegic agents like atropine, with some exhibiting inadequate or delayed dilation.

Discussion

The most common eye condition in the world is myopia. An enormous socioeconomic cost is caused by myopia-associated diseases every year, and complications connected to advancing high myopia, in particular, have the potential to be blinding. Controlling the development of myopia is currently the most effective therapeutic approach. Myopia occurs at a developing phase of childhood at the age of 6-12 years [25]. One of the leading causes of functional visual loss is the progression of myopia in the developing phase of childhood [26].

In East Asia, most of the population is affected by myopia, in this area, another recent study proves that the increasing rate of myopia in adolescents occurs earlier age than in previous generations of this region [27, 28, 29].

Generally, 29% of the population have low myopia (≤-2D) & moderate myopia can be found in about 7% [30].

As per the American Ophthalmology Association, grading of myopia:

- Low myopia = errors≤ -3.00D
- Moderate myopia = -3.00D - -6.00D
- High myopia = ≥ -6.00 D

Myopia can increase in the time of childhood when it can be corrected by a concave lens, contact lens, or surgery. The study by the Academy of Ophthalmology (AAO) shows mean progression of myopia at 0.5D per year [31]. Myopic patients tend to develop an ocular condition such as retinal detachment, complicated cataract, Choroidal haemorrhage, vitreous haemorrhage, open-angle glaucoma & choroidal neovascularisation at the macula [30, 32, 33].

Progressive myopia is defined as an excessive enlargement of the axial length of the eyeball because of an increase in the depth of the vitreous cavity as a result, the parallel light rays from distant objects are focused in front of the retina and form blurred images [34]. Where in this case peripheral defocus by the corrected lenses & orthokeratology may have a greater role in the progression of axial length at the eyeball [35, 36].

The correction of mild to severe correction of myopia by concave lenses or multifocal lenses has weak effects on the correction of myopic eyes [37]. The most important discussion about the correction of the myopic eye by only optical correction could not decrease the risk of vision loss [27].

Myopia is regulated by various factors like environmental & genetic. If both parents are myopic then children have a risk of only 20%, if one parent is myopic then 10% have a chance, if no parent has any myopia history, then only 5% have a risk of developing myopia on this child [30, 23].

Scientists (38)& ophthalmologists are predicting that myopia will increase from 2.6 billion in 2020 to 4.7 billion in the year 2050 [39].

Usages of atropine at lower dosages (0.01%) had better tolerability & efficacy, with minimum side effects. But the other study demonstrated the administration of atropine is linked with various ocular side effects including pupil dilation (mydriasis), sensitivity to light (photophobia), glare, tachycardia, localized allergic reactions, loss of near vision due to paralysis of the ciliary muscle (cycloplegia), irritability or delirium, dryness of mouth, restlessness, and accommodation [23, 24].

The first uses of atropine for controlling myopia progression in the 60s & first clinical trial started in the late 80s [40]. Tropical Atropine eye drops have been used the inhibit myopia progression since the year of 1960 [41].

Numerous clinical trials and studies have demonstrated the effectiveness of atropine in controlling myopia progression, particularly in children and young adults. Long-term data suggest that early intervention with atropine can yield significant benefits in managing progressive myopia.

Key Benefits of Atropine in Progressive Myopia

- Slows down the elongation of the eyeball, a key factor in myopia progression.
- Reduces the risk of developing high myopia, which is linked to various eye diseases.
- Improves visual acuity and quality of life for individuals with progressive myopia.

The use of atropine at low dosage is most effective for reducing progressive myopia in Asian children [37].

However, the regions of the European eye have limited effectiveness in controlling progressive myopia [37].

In the Asian region, myopia presents a maximum number of students of 16-18 years of age [42].

Several studies show that daily use of atropine in a concentration of 1% or lower concentration reduces progressive myopia it is also dependent upon the patient's physiological & biological condition associated with the type of applicable concentration of atropine [43].

Several studies have demonstrated the efficacy of atropine in managing progressive myopia in children. A study published in the Journal of the American Association for Paediatric Ophthalmology and Strabismus found that low-dose atropine was effective in slowing myopia progression with minimal side effects. Another study in the British Journal of Ophthalmology showed a significant reduction in axial elongation in children treated with atropine [44, 45].

In the year of 2006, a study showed that a randomized trial of atropine therapy among 4000 Chinese children proved that atropine is the most powerful weapon for controlling progressive myopia where the mean decrease of progression is 77% compared with another placebo myopic patient [44].

According to a recent 2-year follow-up study conducted on children in the United States, the progression of myopia might be effectively controlled

with 0.01% atropine. The effectiveness of 0.01% atropine on myopia was confirmed by a meta-analysis that was published the previous year, but it did not demonstrate the efficacy of other dosages. Myopia advanced more quickly in the atropine group after the medication was stopped after a year of use, particularly in instances of high-dose atropine (low-dose atropine patients returned less after withdrawal) [45, 46, 47].

The class of Anticholinergics drugs like Atropine sulfate, and Pirenzepine have an important role in developing the retina & regulating the growth of the eyeball, which also can show to slow myopia progression [48, 49]. Like atropine, Pirenzepine 2% has efficacy for slowing progressive myopia at the rate of 50% with twice application in a day [50].

The report of Kinoshita & Retrospective showed that the combined application of both atropine 0.01% & Orthokeratology can significantly decrease the axial length elongation compared to the single application of Orthokeratology [51].

After 12 months of daily Atropine therapy, the rate of progression of myopia significantly decreased [52].

The uses of long-term atropine may be associated with increasing the IOP associated with Glaucoma but the risk is very low 0.005%. Also, another study shows the effects of increasing IOP in children could not be found [53, 54].

Mechanism of Atropine for controlling myopia progression

1) **Via the accommodative pathway:** By competing for binding sites on all muscarinic receptors, atropine, a nonselective muscarinic antagonist, efficiently inhibits the action of acetylcholine. When atropine was first used, the idea was that too much accommodating effort resulted in myopia and that atropine would reverse this impact by eliminating accommodation. Crucial studies, however, contradicted this idea and suggested that atropine didn't predominantly act through the accommodative route as its mechanism. This result was reached based on research that demonstrated the ability of another muscarinic antagonist, pirenzepine, to reduce myopia in chicks devoid of muscarinic receptors in the ciliary muscle. Moreover, myopia may be created in animals without a working accommodative mechanism. As a result, research attention has turned to investigating the retinal, choroidal, and scleral pathways because most mammalian species are known to have muscarinic receptors in these organs.

2) **Via muscarinic receptor pathways in the retina:** Initially, it was believed that atropine's possible mode of action involved altering retinal neurotransmission. In research using chicks, damage to retinal ganglion cells, photoreceptors, and amacrine cells was noted in conjunction with an increase in eye length and myopia. Ironically, though, atropine's capacity to prevent axial elongation was unaffected by the disruption of amacrine cells. It was also shown that the retinal pigment epithelium has muscarinic receptors, which are in charge of sending signaling cascades to target organs like the choroid and sclera. It was discovered that atropine increased the release of dopamine while decreasing the b and d waves of the electroretinogram and attenuating the oscillations of the retinal pigment epithelium potential. This gave rise to the theory that atropine controls eye development by inhibiting essential retinal activities, which in turn releases dopamine. This was corroborated by a plethora of animal research that showed the ability of dopamine or nonselective dopamine receptor agonists to prevent the development of myopia. Furthermore, studies on chicks offered compelling proof that muscarinic antagonists prevent myopia by blocking M4 receptors, which are probably found in the retina. These paths require more investigation.

3) **Via muscarinic receptor pathways in the choroid:** When atropine was administered, the choroid thickened quickly and was able to successfully stop the development of the eye, which led to conjecture on a possible relationship between the two responses. Recent studies using atropine concentrations of both 1 percent and 0.01 percent showed an increase in the thickness of the sub- and para-foveal choroidal structures. The reasons for this thickening were identified as follows: a) decreased choroidal contraction due to inhibition of accommodation; b) decreased excitatory input to choroidal non-vascular smooth muscle resulting in diminished contraction; or c) possible cross-reactivity of atropine, which could block other receptors such as α-adrenoreceptors. Furthermore, atropine was shown to prevent hyperopic defocus-induced choroidal thinning.

4) **Via muscarinic receptor pathways in the sclera:** An alternative viewpoint is that the sclera may serve as the central site where atropine inhibits myopia. Research conducted on chick scleral tissue showed that atropine impeded the production of glycosaminoglycan inside the scleral extracellular matrix. Although atropine is toxic to

scleral chondrocytes at high doses, the finding of decreased glycosaminoglycan production offers an additional mechanism by which atropine may act.

Conclusion

To sum up, the narrative piece has given a thorough summary of atropine's changing function in the treatment of progressive myopia. Now we have a better knowledge of how this drug may slow the advancement of myopia, especially in kids and teenagers. The multidimensional nature of myopia development, influenced by environmental and hereditary variables, was addressed in the study along with the need of early management in preventing long-term problems, including myopic macular degeneration and retinal detachment. We have learned a great deal about the possible advantages and difficulties of using it by investigating its methods of action, historical background, and current study findings. The significance of treating progressive myopia at an early age has been emphasised throughout the text, considering its major effects on eye health and visual quality. Atropine has become a viable treatment option for reducing the evolution of myopia, especially in children and teenagers, due to its ability to block axial elongation of the eye. On the other hand, its effectiveness seems to be dose-dependent, with lower doses perhaps demonstrating a balance between tolerance and effectiveness.

While atropine has a lot of promise, the story has also brought attention to the need for more study to improve dosage schedules, comprehend long-term consequences, and investigate combination therapy for better results. By understanding the mechanisms of atropine, acknowledging its proven efficacy, and addressing practical considerations, we can pave the way for more effective and personalized treatments for individuals struggling with progressive myopia. Furthermore, emphasis has been placed on the significance of customised treatment plans that take into account unique patient preferences and features. Atropine is a useful tool in our toolbox as we negotiate the challenges of treating increasing myopia. By encouraging ongoing cooperation amongst academics, physicians, and patients, we may endeavour to create customised approaches that optimise effectiveness while reducing side effects. In the end, finding successful treatments for progressive myopia necessitates a persistent commitment to patient-centered care, scientific research, and innovation.

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Chapter - 9

Visual Problem: A Review of Prevalence a Study of Visual Impairment in School-Age Children

Abstract

Visual impairment (VI) greatly affects children's academic, career, and social life. Preventing developing VI requires early detection and treatment of underlying causes during the "sensitive" era of visual development. This study of English-language first-hand research addresses VI prevalence in school-aged children globally. VI is caused by refractive error (RE) in 63.6% of instances. RE was the main cause of VI in South Africa, according to RESC. RE was the main source of normal or near-normal eyesight in 87.8% of Vietnamese children. Refractory errors of refraction (RE) caused 81.7% of VI in 5-15-year-olds in India. VI is most often caused by RE (61%).

A Brazilian study indicated that refractive error (RE) causes 76.8% of children's visual impairment in one or both eyes. In Northern Ireland, 8.9% of youngsters had poor vision in both eyes and 26.3% in one. Both eyes had 0.3% significant visual impairment and one eye 0.7%. Low vision and blindness impacted 1694 indigenous Australian children aged 5-15. In the revised ICD-10: 2016, the WHO defined visual impairment as displaying visual impairment and vision loss from uncorrected retinal edoema. The WHO definition of VI is stricter than the VA of 6/12 or less, ensuring earlier diagnosis and treatment of mild VI and preventing persistent problems.

Visual impairment (VI) occurs when VA is below 6/60. However, many low-vision children have useful eyesight for daily tasks. In 1992, the WHO established a functional definition that included distant and near vision. VI is less common in Southeast Asia due to myopia. Uncorrected retinopathy (RE) causes 47% to 92.7% of impaired vision in school-aged children. VI-related amblyopia accounts for 0.3% to 19.0% of patients. Vision 2020: The Right to Sight promotes vision screening and affordable eyewear. Patch or atropine treatment, surgical correction of strabismus and cataracts, and contact lens or glasses reading eye correction can treat amblyopia in adolescence and maturity.

Introduction

Visual impairment (VI) has a significant influence on the lives of those who are afflicted by it, as well as on the lives of their families and on society as a whole. In comparison to when it is acquired later in life, its impact on development and learning is far more substantial when it is present at birth or shortly after delivery. When children have vision loss, it may have a significant impact on their academic chances, career options, and social lives. In particular, children who have near vision impairments may have difficulty performing a range of tasks that involved reading. Because visual presentation accounts for more than 85 percent of what a child learns in school, the child's capacity to achieve at their highest level would be negatively impacted. The kid's ability to complete tasks that involve ambulation in tough circumstances or the application of peripheral vision is also impacted when the youngster has a visual field impairment. In addition, nearly ninety percent of children who are visually impaired do not receive an education that suits their needs. This is due to a number of issues, including stigmatisation, prejudice, and a lack of access to schools that are suitable for them.

It has been reported that the majority of cases of VI are either treated or avoidable in both developed and poor nations. For this reason, early diagnosis and effective treatment of underlying causes during the 'sensitive' phase of visual development continues to be an essential method for the prevention of developmental visual impairment (VI). In order to design a comprehensive vision screening programme that includes accurate and reliable test protocols, it is vital to have reliable data on the prevalence of visual impairment in children as well as the causes of this condition. These kinds of data will be helpful in directing the application of available resources and efforts for early identification to those who are at risk, which will ultimately result in a reduction of the high costs that are incurred by the health system and society in the short and long term. This review of the literature aims to record the prevalence of VI in school-aged children from different locations throughout the world, as well as the factors that contribute to its development. In addition, a discussion on the most important discoveries is offered, with an emphasis on the definition criteria, classifications, and constraints for further research.

Methods

This narrative review employs web sources including PubMed, Medline, OVID, Google Scholar, Science Direct, and Embase to examine the prevalence and aetiology of Visual Anomaly (VI) among school-aged children. The examination focused on first-hand research that had been

published in English and had been subjected to a thorough assessment by specialists in the area. Only epidemiological studies that included assessments of visual impairment (VI) among children between the ages of 5 and 18 were taken into consideration for inclusion in the study. The omission of two studies on visual impairment (VI) in Nigerian children was due to the lack of sufficient data on visual abnormalities in the age groups of 4-24 and 9-21 years old. Several aspects, including the sample size, the sampling technique, the characteristics of the participants, the prevalence rates, the causes, the diagnostic criteria, and the measurement methodologies, are evaluated in this study. A comparison was made between the study based on either the geographic locations or the ethnicity examined.

In a community in South Africa, a comprehensive study known as the Refractive Error investigation in Children (RESC) was carried out. The results of this inquiry found that refractive error (RE) was the predominant cause of visual impairment (VI), accounting for 63.6% of all cases. To everyone's surprise, just 12.0% of the people who were diagnosed with RE were wearing glasses or contacts during the whole evaluation. An investigation that was carried out not too long ago at schools located in the Ashanti Region of Ghana found that 3.7%, 3.5%, and 0.4% of children had visual acuity (VA) of 6/12 or below in their better eye, respectively, when they were not corrected, when they were presented, and when they were best corrected. Based on the findings of the study, refractive error (RE) was shown to be the major reason for poor eyesight.

In order to establish the prevalence of vision impairment (VI) and refractive error (RE) among school children in the Asian region who were between the ages of 12 and 15, a research was carried out in Ba Ria, which is located in the province of Vung Tau in Vietnam. Among the 2258 youngsters who participated in the study, it was discovered that 87.8% of them had normal or near normal vision (≥6/9.5) in their better eye. It was determined that refractive error (RE) was the predominant cause of visual impairment in 92.7% of children who were observed to have vision impairment. A total of 2.2% of cases were attributed to amblyopia. According to the findings of a study done by Goh and colleagues in Malaysia, the prevalence of uncorrected, presented, and best-corrected visual impairment (visual acuity ≤20/40) in the better eye was 17.1%, 10.1%, and 1.4%, respectively.

Refractory errors of refraction (RE) were shown to be responsible for a high proportion (81.7%) of visual impairment (VI) in children between the ages of 5 and 15 years old, according to the findings of an epidemiological study that was carried out in India. There was a 6.4%, 4.9%, and 0.81%

incidence of uncorrected, presented, and best corrected visual acuity (VA) of 6/12 or worse in the superior eye, respectively. The occurrence rate was 6.4%. It was observed in a similar study that included children in rural India who were between the ages of 7 and 15 that there was a decreased prevalence of uncorrected, presented, and best corrected visual acuity (VA) of 6/12 or worse in the better eye. This was the case in the better eye. It was established that the relevant numbers were to be 2.7%, 2.6%, and 0.78% respectively. The majority of the eyes with visual impairment (VI) had reduced vision, and the most common cause was RE (61%).

76.8 percent of instances of vision impairment (VI) in children were found to be caused by refractive error (RE), according to the findings of a separate study that was carried out in Brazil. This condition might affect either one or both eyes. The participants in a research that was carried out in Northern Ireland were youngsters between the ages of five and eighteen years old who lived in a community that had limited resources. It is possible that the criteria that are used to determine visual impairment might explain the substantial percentage of children who were found to have visual impairment among those who participated in the survey. According to the results of the study, the average uncorrected visual acuity (VA) was 0.07±0.13 logMAR. This indicates that 8.9% of the children had impaired vision in both eyes, while 26.3% had impaired vision in one eye. In both eyes, the prevalence of severe vision impairment (VI) with a visual acuity of less than 6/60 was found to be 0.3%, whereas in one eye, the prevalence was found to be 0.7%. Based on the findings of the study, it is recommended that children in Peru have vision screenings on several occasions.

The purpose of the research carried out by Taylor and colleagues in Australia was to determine the extent to which 1694 indigenous children between the ages of 5 and 15 years old were affected by low vision and blindness. The visual acuity of a group of college students was evaluated by the researchers. These students were selected at random from thirty various places around the country. A best visual acuity (VA) of less than 6/12 and equal to 6/60 was characterised as having a prevalence of poor vision, which was found to be 1.5% of the population. It was determined that 0.2% of people were blind, which was defined as having a best visual acuity of less than 6/60. In most instances, the major reason for impaired eyesight was a condition known as refractive error (RE). When compared to children from the wider population, the indigenous children in Australia had a relative risk of 0.2 for vision loss and 0.6 for blindness. This was in comparison to the whole overall community.

Earlier research had shortcomings in their study designs, such as not defining the qualifying criteria for recruiting participants in a clear and concise manner, not giving specific information on the causes of visual impairment (VI), and concentrating mostly on visual impairment in conjunction with refractive error (RE). It is possible that these constraints had an influence on the correct identification of children who were at risk of developing VI as a result of RE. Additionally, they may have impeded the development of effective screening and intervention techniques for the purpose of preventing VI in this specific population.

Discussion

A very significant factor for determining whether or not a kid has visual impairment is the definition of the condition. Up until very recently, the definition of visual impairment (VI) was based on the second revision of the 10th edition of the International Classification of Diseases (ICD) [28]. This modification was subsequent to a study of blindness conducted by the World Health Organisation (WHO) in 1972, which proved that the best corrected VA should be used as the foundation for calculating VI. At that point in time, RE was not seen as a priority and was not recognised to be a major cause of VI. As a result, it was not included in the estimates of the overall number of people who had VI. Uncorrected RE, on the other hand, is a considerable contributor to the overall number of people who have VI, according to the findings of current population-based research. As a result, the World Health Organisation (WHO) established a new definition of visual impairment (VI) in the updated edition of the International Classification of Diseases (ICD-10): 2016, which makes use of presenting visual impairment (VA) and vision loss from uncorrected retinal edoema (RE) [31]. Low vision, also known as moderate and severe impairment, is characterised by this categorization as a visual acuity (VA) that is less than 6/18 but equal to or better than 6/120, or a visual field loss that is less than 20 degrees diameter in the better eye with the greatest available refractive correction.

Although the majority of the studies that were examined classified VI as a VA of less than or equal to 6/12, a wide variety of definition criteria were used in its diagnosis. These definition criteria ranged from a VA of 6/9 or less to less than 6/12. One of the research that was evaluated, Ajaiyeoba *et al.* [12], did not specify the definition criterion for VI. The utilisation of a VA of 6/9 in some studies will result in an overestimation of the prevalence of VI, which will have a significant impact on the cost of intervention services for affected persons. Additionally, this will have a significant psychological impact on the children who are impacted and their families. On the other hand, Megbelayin

and Asana [13], who defined VI as a VA of 6/9 or less, observed a greater incidence of VI in comparison to previous research [14,17, 18] that utilised a VA of 6/12 or worse. This was the case when comparing their findings to those of other studies on African children.

There was also a tendency that was detected in the research that were carried out in the Americas. For example, the study in Peru that used a VA threshold of 6/9 or less indicated a greater prevalence of VI than another study in Brazil. Studies have shown that the mean visual acuity (VA) in early toddlers was 6/7.5, and that an acuity of 6/12 or below would have a detrimental impact on their vision [33] and might significantly diminish their functional performance. The VA of 6/12 or less, which was utilised by the RESC research, is a superior indication to accurately quantify the amount of VI owing to RE and to properly measure the need for eye care services, even those with mild VI. This is because the WHO definition of VI is more stringent than the VA of 6/12 or less. The usage of this will also guarantee that the underlying reasons of moderate VI are detected and treated in a timely manner, preventing them from developing into permanent conditions.

Classification of Visual Impairment of the Eye

According to the categories of visual impairment that were utilised by the majority of the research that were examined, a person who has a presenting visual acuity (VA) that is lower than 6/60 should be considered blind. On the other hand, a sizeable proportion of children who are labelled as blind nonetheless possess vision that is useable and are able to independently carry out activities of daily life. According to reports, roughly twenty percent of youngsters who are classified as blind in underdeveloped countries, such as in Africa, were discovered to have considerable residual eyesight. Although children with low vision may have some useful vision that can support other activities of daily living if they are taught how to use it appropriately, the implications for rehabilitation and education are that they may be educated using techniques that are appropriate for those who are completely blind. This is the case even though they may have some useful vision. In the case of children who were previously categorised as blind but were able to read with the use of Braille, for example, roughly 66% and 1.45% of those youngsters were determined to have poor and normal vision, respectively, once best refraction has been performed. As a result of the significance of functional vision, the World Health Organisation (WHO) included an additional viewpoint in the definition of VI in the year 1992. This perspective encompasses both distant and close vision. A person is considered to have low vision if they have a vision in their better eye that is less than 10 degrees from

the point of fixation (or 20 degrees across), and if they use or are potentially able to use their vision for planning or carrying out a task. This definition states that a person with low vision is someone who has impaired visual functioning even after receiving treatment and/or having their refractive error corrected. People who have poor vision but have a VA of less than 6/120 are eligible for relevant assistance and are included in low vision programmes thanks to this functional definition, which guarantees that they are protected from discrimination.

Regional Differences in the Prevalence of Visual Impairment and the Factors That Contribute to It the incidence of VI and the factors that led to its development differed from area to region. When compared to children in other locations, particularly those in Southeast Asian nations, studies have shown that the prevalence of VI is lower among African youngsters. One possible explanation for this is because there are not enough comprehensive epidemiological investigations conducted in poor countries like Africa. One possible explanation for the increased incidence of VI in Southeast Asian nations in comparison to other regions is that these individuals have been documented to have a high prevalence of myopia and a very severe form of the condition.

Myopiagenic factors include

1) A genetic predisposition, such as ethnicity and a family history of high myopia.
2) Intensive near work activities due to competitive education and schooling systems are common among Southeast Asian children, with myopic eyes being at risk of developing functional VI at a relatively young age.

Myopiagenic factors are a common cause of myopia in Southeast Asian children. Furthermore, the causes of VI differed greatly from one study to the next. This variation may be related to variances in socio-economic trends as well as the disparities in the availability of screening procedures that are both effective and comprehensive. These variables can all have an impact on the prevalence of VI as well as the aetiology of the disease in various places.

The Factors that Contribute to Visual Impairment in Children of School Age

Uncorrected retinopathy is the second greatest cause of curable blindness among individuals of all ages, and it is also one of the primary causes of visual impairment (VI). This is proven by the studies that were examined, which

found that uncorrected retinopathy (RE) was responsible for 47% to 92.7% of the impaired vision in children of school age, whereas amblyopia was responsible for 0.3% to 19.0% of the cases. The conditions of strabismus, anisometropia, and congenital cataract, as well as the less common condition of media opacification, are all considered to be risk factors for amblyopia. It is believed that simple RE, which is not linked with amblyopia, may be corrected with the use of proper glasses and does not have an impact on normal visual development. This is in contrast to the visual impairment that is connected with amblyopia. Over 19 million children under the age of 15 will be diagnosed with VI over the world, with 12.8 million of those cases being caused by uncorrected RE, as stated by the World Health Organisation (WHO). As a consequence of this, the project known as Vision 2020: The Right to Sight has listed the rectification of RE as one of its primary goals. The aim of the effort is to promote vision screening at educational institutions and to make eyeglasses available at reasonable prices. In a same vein, amblyopia can also be efficiently treated by the early discovery and repair of the underlying amblyogenic risk factor.

The information that is now available, on the other hand, suggests that amblyopia can be treated, even in the adolescent years. According to the findings of other investigations, increases in binocularity and visual acuity in the amblyopic eye can also be achieved well into adulthood. Some of the therapies that are available for amblyopia include the application of a patch or atropine therapy to the eye that is afflicted, surgical correction of strabismus and cataracts, and reading eye correction through the use of contact lenses or glasses. On the whole, the majority of the VI that occurred in the study populations was caused by conditions that could be treated.

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Chapter - 10

A-Scan Technique: Immersion Vs Contact. Which One Should Be The Ideal? Patient Data and Survey Report

Abstract

Purpose: The study reveals the differentiation between the ocular biometry values between immersion and contact techniques in order to determine the most prominent method for qualitative and quantitative purposes. This is a comparative study between two types of A-Scan techniques (i.e. Immersion and Contact) in order to dictate which one should be the ideal for patient's sake and accuracy level in finding the precise IOL power.

Methods: The study was a comparative cross sectional study conducted on about 100 eyes (100 patients) undergoing different types of ocular biometry methods to reveal the difference between the A-scan measuring parameters. A 10 MHz sonomed probe was used as an ocular biometry diagnostic equipment for both contact and immersion method and a Scleral shell (Prager) was used for only immersion method.

Results: This study elaborates a significant difference between contact and immersion method of A-Scan. All total 100 eyes of 100 patients were collected as a sample size in which 54 were reported as male and 46 reported as female (only one eye undergone both the methods of A-scan of every patients) making a ratio of 1.2:1 (male: female ratio).

The mean of the biometry values in immersion was 23.56 mm (±1.36) and mean value of biometry in contact was 23.40 mm (±1.44) respectively of axial length. The mean difference of axial length in both the methods was 0.16 ± 0.21mm (range 0.0-0.168mm); this difference was within 0.16 mm in 58 cases (58%) and more than 0.16 mm in 42 cases (42%).

The SD was 0-0.05 mm in 89 eyes (89%) measured by immersion technique whereas 33 eyes (33%) by contact technique. SD was 0.6-0.1 mm in 7 eyes (7%) in immersion and 26 eyes (26%) in contact. Also SD greater than 1 mm showed in 4 eyes (4%) in immersion technique and 41 eyes (41%) in contact technique.

Introduction

A-Scan (A stands for Amplitude) ultrasound is an important diagnostic method in pre-operative evaluation of cataract surgery patients, as it gives the appropriate dioptric power of intraocular lens (IOL) which is implantated during cataract extraction surgery.

Cataract is a physiological change in crystallaline lens in which proteins breakdowns occurs in lens which causes blurry vision or hazy vision. In such condition, cataract extraction surgeries are performed by placing or implanting a dioptric poweredartificial lens, which is calculated by performing A-scan technique. Modern cataract surgery is considered as one of the form of refractive surgery as because after cataract surgery the patient's vision clarity is restored by placing accurate IOL power determined using ocular biometry technique.

A-Scan is a 1-D (dimensional) display in which echoes represents as vertical spikes and these spikes determine the reflectivity, size and location of anatomic structures. Ocular biometrics measures different parameters which are illustrated as axial length, anterior chamber depth and lens thickness through different methods of A-scan techniques.

The working principle of A-scan is that, it involves passing of ultrasonic beam via a transducer through the eye and it returns after hitting different ocular structures which leads to display of spikes when traced between cornea to orbital fats.

Ultrasound principle

The sound is determined as it is a vibratory disturbance within solid or liquid medium that travels in a wave pattern. In case, when the frequency of the sound wave is in between 20 Hz to 20,000 Hz it is audible to human ear.

Likewise in ophthalmology A-Scan and B-Scan probe uses a frequency of approximately 10 MHz (Million Hertz) which is designed by the manufacturer.

The velocity of the sound depends upon density of the medium through which it passes.

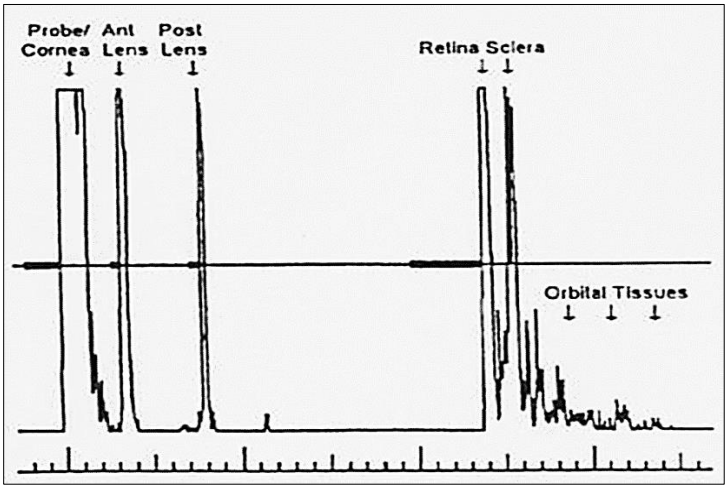

Fig 1: Graph of A-scan (immersion and contact)

Types of a-scan techniques

Ocular biometry values are obtained through different methods that are contact (applanation), immersion methods and optical method.

1. Contact (Applantion) method

This method of ocular biometry is widely used in which the 10 MHz probe is placed at the central cornea which results in slight indentation of corneal structure leading to some degrees of corneal compression which may cause some amount of errors into the values.

As the probe is directly placed over the cornea, the patients finds uncomfortable, so some local anaesthetic topical drops (Paracaine drops) are instilled in the eye which results in loss of sensation for time being and then the probe is placed over the corneal surface.

Fig 2: Contact method of A-Scan

2. Immersion method

The immersion method is performed with the help of saline filled scleral shell also known as Prager between the eye and the probe.

Likewise as contact method, a local anaesthetic drops (Paracaine drops) is instilled and then the shell is placed over the scleral portion.

Fig 3: Immersion method of A-Scan

3. Optical method

This is a non-contact method based on PCI (Partial coherence interferometry) that is most prominently used as because it is potentially more accurate. Both immersion and optical methods of biometry gives comparative results.

Although the main disadvantage of optical method is that, this method is unable to obtain the axial length in different cases which includes dense or total cataract, dense PSC+++, nystagmus, unstable lids.

As of now during cataract surgery, most of the cases are presented are dense making the optical method inapplicable in our environment.

Fig 4: Optical method (IOL master)

Axial length is the vital component in IOL calculation. Studies have shown that a 1mm change in AL results in refractive error of approximately 2.40 D error of IOL power in average eye of 23.4 mm and the error may increase in shorter eyes. According to the studies, the errors in implanted IOL is the sum of random error in measurement of axial length(56%), measurement of corneal powers(9%), measurement of anterior chamber depth(ACD)(35%).

As a result, a study was conducted in order to compare the contact method and immersion method using A-scan ultrasound device (BIOMEDIX) at our hospital. The device which is used for the study has capability to measure in different conditions such as immature cataracts, mature or total cataract, vitreous haemorrhage or retinal detachment where optical biometry cannot be performed due to its limitations.

Review of literature

This is meta-analysis and a cross-sectional study which gives a significant difference between immersion and applanation (contact) methods of A-Scan. All total 92 eyes are taken as a sample size on which both method of biometry are performed in order to determine the most reliable and suitable method of A-scan [1].

The study states the methods of A-scan through which the IOL power is been calculated. It also suggests the accuracy of immersion is better than the contact method.

Illustration of role of A-scan in pre-workup of cataract management is reviewed.

Therefore most of the articles suggest that the immersion method is better method or technique than the contact and optical. Optical has its own limitations so it is used up to an extent [2].

Aim and Objectives

AIM of study

The aim of the study is to determine which A-scan techniques between immersion and contact is ideal to use for patient's sake and accuracy level.

Null Hypothesis (H0): There is no significance change in different measured parameters between immersion and contact techniques.

Alternate Hypothesis (H1): To study the change between different measured parameters (axial length, lens thickness, anterior chamber depth) between immersion and contact A-scan techniques.

Objectives

The objective of the study includes followings:

- Identifying the ideal A-scan techniques between immersion and contact.
- To determine which method is suitable for patient's sake and accuracy level for IOL powers before cataract surgery in different types of cataract.

Materials and Methods

A comparative cross-sectional study was carried out between September 2022 to April 2023 at ophthalmology department of a corporate eye specialty hospital, Bhubaneswar, Odisha.

Study design: This is based on a comparative, cross sectional analysis and transverse study.

Inclusion criteria: Inclusion of patients prominently from rural areas who visited hospital for cataract surgery procedure with condition of different types of cataracts. Both male and female patients with age group more than 35 years were included in this study.

Exclusion criteria: More precisely any ocular pathological conditions which may misguide the study are excluded from analysis.

Sample size: A total of 100 eyes data is reported under the study which undergone both immersion and contact A-scan techniques.

Methodology

The study is a comparative transverse analysis on the patients who visited hospital for cataract surgery, more precisely from the rural areas and patients who randomly visited out-patient department. A comprehensive eye examination including detailed history, chief complaint, visual acuity, objective and subjective refraction, intra-ocular pressure, pupillary reaction, non-dilated slit-lamp examination were conducted by three optometrists of the department.

Later, patients were dilated (Tropicamide plus/Tropicamide plane) and being diagnosed by doctor or surgeon of the hospital. After the confirmation of the ophthalmologist, the patients were taken to ocular biometry rooms for measurement of IOL power.

At diagnostic department, both techniques of A-Scan i.e. immersion and contact method was performed, at first immersion technique followed by

contact technique was carried out by the same examiner. Measurement of Axial length, anterior chamber depth, lens thickness and its standard deviation were determined with A-Scan (BIOMEDIX) machine, having a 10 MHz probe for both contact and immersion.

Procedure

For immersion method:

1) For immersion method, the patient was asked to lay down on patient bed in a supine position by giving the patient's its own thumb as a fixation target for the other eye.
2) Later, a local anaesthetic drop is instilled in patient's eye for loss of sensation for limited time being.
3) Subsequently, a scleral shell (Prager) was placed on the scleral part which was filled with saline and connected by a silicone tube to a 5ml syringe. The 10 MHz probe was placed through the centre of immersion shell resulting in some gap between the eye and the probe which was filled with saline.
4) Automated sequences of ten readings with standard deviation were taken and noted.

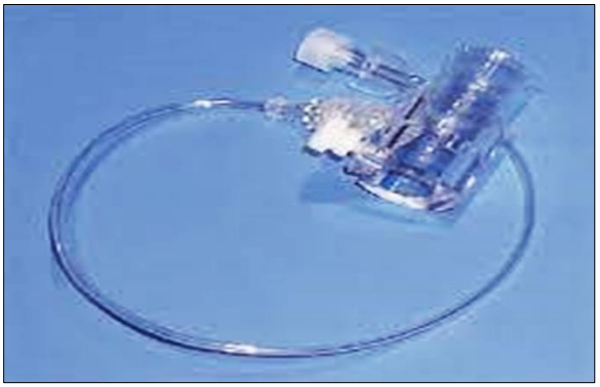

Fig 5: Prager (Scleral Shell)

For contact method:

1) For contact method, the patient is asked to sit in an erect manner on the patient chair and is asked to look straight ahead at distant as a fixation target.
2) Likewise, a local anaesthetic drop is instilled in patient's eyes as because the probe is directly placed over the corneal surface.

3) After the probe is placed over the cornea centrally, automated sequence of ten readings were taken and noted.

For both techniques, ten readings with its standard deviation was taken and noted.

The Holladay II formula was used if the axial length was 21mm or more and SRK II formula was used if the axial length was less than 21mm.

Results

The study was conducted on about 100 eyes which were undergone both the immersion and contact techniques and their biometry values were noted in order to determine the mean difference between both methods.

The study includes both male and female of the total cases in which 54 were males (54%) and 46 were females (46%) making a ratio of 1.2:1 (male: female ratio). Age group ranges from 35 years to 84 years of age with a mean of 59.5 (SD ± 18.8) years.

The average axial length was ranging from 22.5 to 24.35 mm which was most common measured in about 78 cases (78%) in both the methods. The mean of the biometry values in immersion was 23.56 mm (±1.36) and mean value of biometry in contact was 23.40 mm (±1.44) respectively of axial length. The anterior chamber depth difference was fair; the mean difference of ACD in immersion ranges 3.18 and in contact ACD ranges 3.26 mm. The mean of lens thickness ranges 3.85 and 3.59 mm respectively in both the methods.

The result indicates that there was significant difference between axial length and marginal difference between ACD and lens thickness in between both the standard methods. The mean difference of axial length in both the methods was 0.16 ± 0.21mm (range 0.0-0.168mm); this difference was within 0.16 mm in 58 cases (58%) and more than 0.16 mm in 42 cases (42%).

Table 1: Informative table of the study for the biometry readings in immersion and contact techniques.

	Minimum	**Maximum**	**Mean**	**Standard Deviation**
Axial length by immersion (mm)	21.84	32.42	23.56	1.36
Axial length by contact (mm)	21.05	31.90	23.40	1.44
ACD in immersion	1.96	5.58	3.18	0.63
ACD in contact	2.40	5.20	3.26	0.52
Lens thickness in immersion	0.00	5.65	3.85	0.97

Lens thickness in contact	0.00	5.71	3.59	0.92
Difference in axial length between immersion and contact A-scan	-0.46	0.156	0.16	0.20

Standard deviation was evaluated of both immersion and contact on the measured eyes which significantly shows more deviation in contact compared to immersion in the terms of axial length.

SD of individual eye showed a mean of 0.03 ±0.04 (0.0-0.3) mm in immersion and 0.15 ±0.12 (0.0-0.6) mm in contact technique. The standard difference between both eyes were poorly correlated.

The SD was 0-0.05 mm in 89 eyes (89%) measured by immersion technique whereas 33 eyes (33%) by contact technique. SD was 0.6-0.1 mm in 7 eyes (7%) in immersion and 26 eyes (26%) in contact. Also SD greater than 1 mm showed in 4 eyes (4%) in immersion technique and 41 eyes (41%) in contact technique.

Following figure no.6, indicates the standard deviation of axial length between both immersion and contact methods.

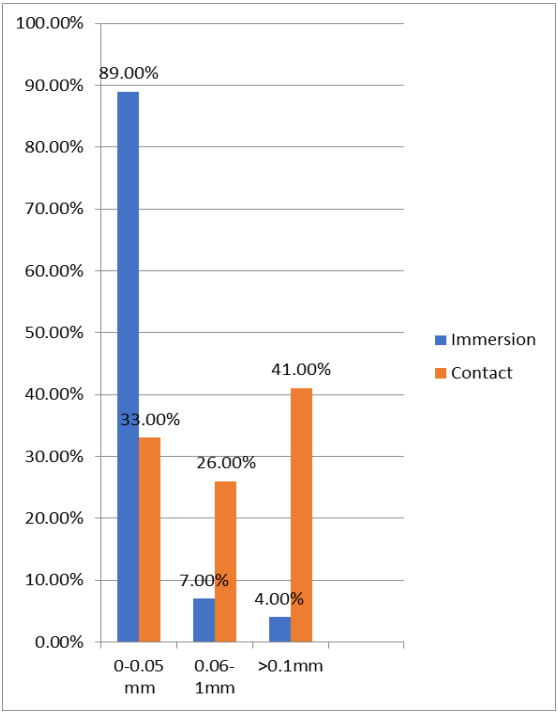

Fig 6: Indication of standard deviation of axial length in immersion and contact methods.

Discussion

In ophthalmology department, cataract surgery is the most common and basic type of surgery. As cataract is a physiological change in the crystalline lens which often develops after 58-60 years of age. As known in the study, an IOL is implanted of precise dioptric power which is calculated using A-scan techniques. Both immersion and contact methods of ultrasonography are carried out in order to calculate IOL powers. The foremost parameters such as axial length, ACD, lens thickness are being calculated via mentioned methods of A-scan.

In this study, the immersion method gave a longer axial length as compared to contact. In immersion, there is shell used known as Prager which helps in preventing the direct contact with cornea as it is a saline based technique. The shell helps in stabilizing the globe which keeps eyelids open and allows proper alignment of probe with visual axis. On the other hand contact method is performed by directly placing the probe over the corneal surface which results in corneal compression which sometimes gives miscalculation of IOL power if indented more.

Due to this contact method, corneal compresses the surface which results in decreased anterior chamber depth which ultimately leads to shorter axial length. This creates a difference between immersion reading and contact reading.

This study gives a mean deviation and a standard deviation between these two methods of A-scan statistically. Study gives a difference between all measured parameters of A-scan but significantly axial length difference is the matter of concern.

Conclusion

It has been concluded that in between the contact method and immersion method of A-scan, the immersion method is attributed with greater accuracy and greater sensitivity. Due to the absence of any corneal compression and displacement of the probe the immersion technique gives the most accurate ocular biometry values.

Corneal compression is the only factor which makes contact technique less validated than the immersion. As because immersion technique is performed using a coupling fluid (saline) which prevent the direct contact of probe with cornea.

So therefore, immersion method is most suitable and precise method of A-scan in terms of accuracy and patient’s sake.

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Chapter - 11

Exploring the effects of NdYAG Capsulotomy and Changes of IOP during Post-Surgical Condition

Abstract

Significances

In the eye care sector, cataract surgery is most significant to correct reversible blindness occurred from cataract formation. Normally cataract is nothing but the age related changes for crystalline lens that is vital for refraction and focusing light rays into the retina for a healthy vision. Due to ageing and age related changes, crystalline lens became cloudy and opaque with the changes of refractive index. Cataract surgery is performed to remove the lens with sclerosis and that is replaced by the intraocular lens also called artificial lens so that cloudy nature will be eliminated and vision again restored. But in many cases it is also found that lens opacity again formed and makes the IOL into an opaque media. In many article study it is found that different types of scar cell formations and depositions is responsible for the clouding condition of IOL in such condition it is also termed as a secondary cataract and that again responsible for lowering the visual equity. In such type of cases, YAG capsulotomy is most useful and becoming popular day by day and normally application is necessary during the case of posterior capsular opacification cases (PCO). Within two years after cataract surgery PCO can be occurred and laser used to clear the opacity again and make that surface clear for the refraction media. Laser normally used for creating an insertion without invasive technique but it becoming popular due to lower complications. Also there is a lesser chance of corneal injury, corneal burn, vitreous humor changes and damage, less inflammatory changes etc. due to the non-invasive technique but in case of YAG capsulotomy, there is also various types of complications also may arise like intraocular pressure changes, vitreous damage, corneal inflammatory changes etc. Normally PCO conditions are reported by the patients already faced by cataract surgery that completed and complications occurred within two years. 20.7% patients found that affected by PCO and reported within the two years of surgery and again 28.5% patient found within the five years of cataract surgery. There are some

complications also arise like corneal burn, arising intraocular pressure, lens damage and weak condition, retinal detachment etc. can be occurred due to PCO operation by YAG capsulotomy. Most of the cases that clouding phenomena repeated that significantly cloud formed with elevated IOP. In most of the cases that significant amount of IOP increase is noticed after PCO surgery by YAG laser surgery. Vitreous solid particles, cell debris, etc. may create blockage into the drainage angle that is responsible for increasing glaucomatous tendency. In some studies, we may find that the tendency of arising IOP attain the ear capsule on that particular eyes.

Objectives

- Study and discussion about the PCO Significance of Yag Capsulotomy
- Ocular manifestation & Intra ocular pressure changes due to surgical issue.
- Analytical works to find the population averages affection by high IOP after YAG Capsulotomy.

Aim of study

The main purpose of the study to find the adverse effects and complications of YAG capsulotomy regarding intra ocular pressure changes of those patients recently faced YAG capsulotomy and also observe the frequency of that study.

Hypothesis

It is hypothesized that IOP tends to rise following Nd: YAG capsulotomy

Keywords: Cataract surgery, YAG lesser, Capsulotomy, PCO treatment, IOP fluctuation, surgical side effect

Introduction

In this research study, main object is to investigate and find complications occurred from capsulotomy surgery guided by YAG Laser mainly about the changes of pressure inside eye ball (IOP). Normally capsulotomy is performed to clean up the intraocular lens that is affected by scar and cell deposits and ultimately from the opacity. Normally Phacoemulsification surgery is performed to eliminate the cataract. That is, age related changes occur to the crystalline lens due to the clouding and form the opacity to the crystalline Lens. On the basis of sclerosis parts it can be classified as Polar cataract (when lens hardening is forming at the polar area), cortical cataract (when sclerosis started at edges area), posterior sub capsular cataract (smallest area at the back

affected with sclerosis), nuclear sclerosis, etc. Normally the age related cataract started from the nucleus part of the crystalline lens. So it is termed as a nuclear sclerosis. In this condition, the central part of The lens that is termed as the Nucleus that become sclerosed and gradually with the color changes can be seen under slit lamp as amber colored and dark yellowish color then gradually it spreads from the Central to the peripheral areas according to the Aging and beside this the increasing of sclerosis also referred to Index changes and clouding than can be observed. The only way to relieve from the conditions is the cataract surgery. The cataract surgery procedure can be discussed as intra capsular and extra capsular way. Normally crystalline lens is located inside the capsule. So in case of extra capsular way total structure is removed but nowadays it is not followed. Another way is found as only remove the nucleus part of the lens and nowadays it is followed by the by the surgeon as Phacoemulsification procedure. After cataract surgery At least 28.5% of patient reported within the five years after cataract surgery due to the posterior capsular opposition conditions and they reported the clouding of lens that forms again with lowering the visual acuity within the five years of the of the cataract surgery and also 20.7% patients that reported and diagnosed about the posterior capsular Opacification conditions within the two years of cataract surgery. That duration of posterior capsular opacification formation that depends on the blood pressure, diabetes mellitus, etc systemic conditions also that plays a vital role. In case of higher level of Blood sugar, there are higher chances to form the posterior capsular opacification conditions with inflammatory changes. In case of infectious changes, then there will be higher chance for the PCO formation. Normally PCO formations can be occurred due to the cell debris depositions and during the inflammatory changes with scar cell deposition at the posterior part of the lens capsule. In such conditions refraction media become opaque and this is removed by the YAG Laser capsulotomy. This is a not an invasive Technique as per the procedure, but that applied over that particular area where the cell deposited and precipitation occurred. After clean up that area with YAG laser so that light can pass through this structure and can focus on to the retina for healthy vision formation. But due to YAG capsulotomy complication may arise as retinal detachment, IOP increase, vitreous affected etc. In these cases we will find the complications as IOP spike changes of those patients recently faced YAG capsulotomy to measure the frequency and the amplitude.

Literature review

In an article, Nathan *et al.* discussed about the research activity regarding Nd. YAG capsulotomy surgery performed by optometrist and about the

quality of surgery and complications. Normally, In case of posterior capsular opacification cases need to clear the posteriorly deposited collagen and precipitation with help of YAG laser shots. The motive of this article was to find the cases of YAG capsulotomy performed by optometrist already completed Doctor of optometry and research about surgery quality with their significant complications. It has been seen in many research study that complications like higher intraocular pressure is detected. In this study, author team selected 79 patients from which 92 is taken as subject to conduct the survey. In all this experiment conducted from six separate healthcare centers for the investigation. As per inclusion criteria, monocular posterior capsular capsulotomy cases taken when visual acuity is less than 20/40. Complicated cases like severe glaucomatous changes, degenerative changes, diabetic and hypertensive changes with other retinal complications avoided as exclusion criteria. Visual equity measured and noted as per LogMAR unit and GAT performed to test about standard IOP. In manximum cases it is found that mild fluctuations after one hour test found like 5mmHg but it become stable within 1 week with normal limit[1].

In another study conducted by Jayne Ge *et al.* About longer duration effect after having capsulotomy regarding fluctuations of IOP level. They have conducted experiment over 100 patient and found that significant increase of intraocular pressure. Especially those patient experienced elevated IOP, maximum reported after 1 hour duration of capsulotomy surgery. Age group taken as 75 to 80, including glaucomatous conditions. It is also found that higher IOP level detected after application of capsulotomy if compared to eyes till not undergo the capsulotomy. Glaucoma patients need more associated antihypertensive ocular medication to control IOP level after facing Nd.YAG Capsulotomy[2].

In another article written by Mr. Shivanandi about YAG capsulotomy procedure and expected outcome after surgery. According to him, YAG capsulotomy is a simple laser surgery procedure When laser is used to clean up the lens capsule normally after cathartic surgery, within one year due to cell and collagen deposition over the lens capsule, it became opaque and responsible for posterior capsuler opacification.Here, Nd. YAG laser is used to make a small opening within the lens capsule so that light rays can easily pass that media to focused on the retina properly and that debris and deposition can be eliminated from that area[3].

In an article by Leslie Sabbagh discussed in detail about YAG laser about its complications, older technique and newer technique comparison, percentage of complications, etc. In this article it is also mentioned about

longer period complications after YAG Laser capsulotomy surgery performed by doctors. It is proved that it is safest but also has complications. As per authors view complications may cause like retinal detachment is prominent in so many cases but from various study material only 2% cases found about retinal detachment caused due to Nd.YAG laser durung post-surgical condition. But due to disruption of anterior vitreous body it may cause floaters in maximum cases and also mentioned about the IOP increased because of impaired aqueous humour drainage that can deteriorate quality. In many cases it is also responsible for triggering aging factors degenerative cases etc[4].

In another article, Lo Bu Sa *et al.* also conducted a research activity to observe the vision improvement in case of Nd YAG capsulotomy laser surgery for the patient implanted with trifocal intraocular lenses. During the study and discussion about ocular complications due NdYag laser capsulotomy also mentioned here that IOP balancing hampered and chance of higher intraocular pressure reported with central macular edema and also chances of retinal complications. Beside this retinal detachment tendency noted with hyperperopic shift also.Controlling and lower power shot of lasers along with capsulotomy area not more than 5 mm can make chances of complications mentioned here to the lower level. Treatment during the early conditions of PCO formation may need lower areas of laser surgery less then 5mm with lower numbers of laser shot may decrease complications with also lowering chances of hyperopic shift[5].

In another study by Takeshi et al about possibilities of corneal complications due to excess laser shot in case of PCO treatment with capsulotomy.Here it is described about the significance of a capsulotomy in case of posterior capsular opacifications and also it is stated that it sometimes is responsible for blood efficient poor contrast sensitivity with halos as reported by patients.Beside this, here also author stated about intraocular pressure, elevated level with system cystoid macular edema formation, increased chance of retinal detachment, endothalmitis, etc.These all cases discussed here to demonstrate Yag laser complications and also to increase patients awareness[6].

In a research study by Hashim Thiab hasan also discussed about the elevation of the pressure within eye ball after performing Nd.YAG laser capsulotomy surgery at Iraq.Cataract is type of age related changes and cloudiness of crystalline lens. After phaco emulsification surgery in many cases again posterior lens capsule become opaque due to collagen and ac cell depositions.Yag Capsulotomy is considered as the safest sugical treatment procedure but also has complications.The significant complications

considered as elevated IOP and in that in that in that article study, the aim was to find the percentage of patient already treated with Yags capsulotomy photo disruption procedure for PCO treatment about the IOP increase limit after 1 hour then after 24 hours and changes after one week. They used GAT to find the standard value of interocular pressure reading. They considered that fellow eyes not treated with YAG laser as a control group. They found 2-5 mmHg IOP fluctuations record after 1 hour, that is about 30% and a few patients approximately 24% showed a result as 10 mmHg fluctuations. Anti-hypertensive glaucoma drugs applied to lower that, which tends the limit to 13.24mmHG considered as the normal limit[7].

In a study by Niharika, K shetti *et al.* also aim to find the IOP fluctuation level after performing posterior capsular opacification surgery by NdYAG laser as it is considered that complications like IOP fluctuation, IOL cracking, edema, retinal complications like degeneration and detachment etc. associated with Nd YAG laser surgery. Beside this, corneal degenerative changes, vitreous humor, also significant other diseases that also may increase IOP conditions like glaucomas changes, infections in anterior Uvea, higher refractive error specially myopia etc. excluded from the study. They also found higher IOP fluctuations level especially in case of 40 shots showed significant result in IOP elevation result in P value (0.05).In some cases hyperopic shift of refractive error also noted due to posteriorly displaced IOL[8].

In a research article study from medical research journal conducted about improvement of visual acuity with complications like IOP fluctuations due to Nd YAG laser surgery capsulotomy procedure. Study conducted over 200 patients cases and age limit considered as 40 to 70.YAG laser is considered as a safe procedure solid state laser used for posterior capsular opacification elimination but significant IOP elevation found during post-surgical conditions was found as transient condution. Steroids with antibiotic applied to reduce inflammatory symptoms and few patients showed about higher IOP after one hour of surgery managed by timolol 0.5% eye drop showed improvement within 24 hours[9].

Study from American Academy of Ophthalmology by Roger F stainert discuss all about YAG laser capsulotomy about its procedure, outcome and complications. YAG laser is considered as type of solid laser with 1064 nm wavelength that can disrupt ocular cells and tissues. It is included in medical surgical instrument to apply this principle of photodisruption to the medical field. It is also known as a safest and less expensive surgical way of capsulotomy to eliminate cell debris and deposition from the posterior capsular part in maximum cases after cataract surgery. It is taken

approximately two years to form the opacification at the posterior capsular part but in youngest patient and tendency is lower found in case of elder age limit in some cases. It is also found that diabetes cases have the lower tendency to form posterior opacity capsular opacification compared to the non-diabetic case. Posterior capsule opacification may caused due to a cloudyness in membrane formation or epithelial cell proliferation and transformation into the posterior part of lens capsules. Depositions and opacification after a capsulotomy cell debris and deposition can be eliminated so that visual equity improved up to 96% cases. But if already patient is affected by corneal scar, ARMD, cystoid macular edema, RD, ischemic disorders, etc. may cause lower improvement of visual aquity after YAG capsulotomy laser surgery but also create complications like hugher IOP level.67% case reported around 10 mmhg IOP fluctuations and elevated amount after surgery but it will become stable after 24 hours and within one week it becomes stable to normal limit in case of pre-existing glaucoma can affect more with IOP increased and lower the visual acuity, light sensitivity and visual perception. Actually, in case of cell debris, ac cell vitrial cell liquefication, damage in trabecular meshwork may decrease aqueous humour outflow that deteriorate of IOP control and responsible for high Intraocular pressure. In that cases, anti-inflammatory antibiotics and antihypertensive glucoma medicine like beta blocker may be helpful to reduce the state to control pressure into normal limit [10].

Methodology

In this analysis total sample size randomly taken from the age group 40-80 years old. Total 24 female patients counted here and 10 male patients included. Before the YAG capsulotomy all the clinical data's collected as age, gender, IOP measurement before the surgery then IOP measurement after the surgery with number of laser shot also counted here.

Study design: This was a prospective study

Study location: The study was conducted in MR Bangur hospital

Duration of the entire study: All the medical data including all necessary clinical diagnostics informations collected during the time 15th April 2024 to 10th June 2024

Inclusion criteria: Patients who are faced Nd: YAG Capsulotomy at least in one eye included here

Exclusion criteria: Patients with glaucoma case or such type of family history or undergoing glaucoma treatment, myopia, and recent ocular surgical history were excluded.

Materials

Assessment tools: Appasamy NCT and YAG capsulotomy machine were used in the study

Assessment process: The selected patients' IOP was recorded using NCT before capsulotomy. Repeat NCT reading was taken 1 hour after capsulotomy

Age limit is further divided as:

Age limit	Patient count
40-50	6
51-60	9
61-70	5
71-80	4

According to the Age level IOP measured before the surgery with mean value

Age limit	IOP range mmHg	Mean value mmHg
40-50	12-18	15
51-60	14-17	15.5
61-70	10-16	13
71-80	12-18	15

According to the Age level IOP measured after the surgery with mean value

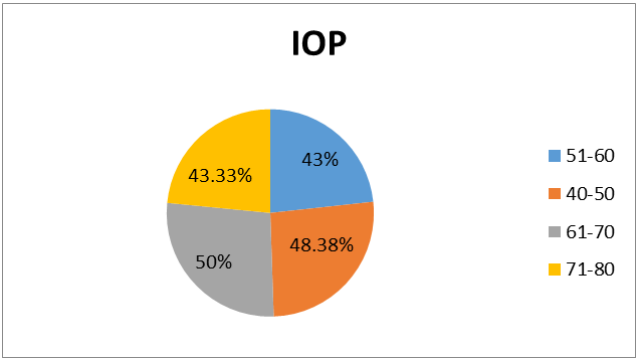
Age limit	IOP range mmHg	Mean value mmHg
40-50	19-24	21.5
51-60	22-24	23
61-70	15-24	19.5
71-80	19-24	21.5

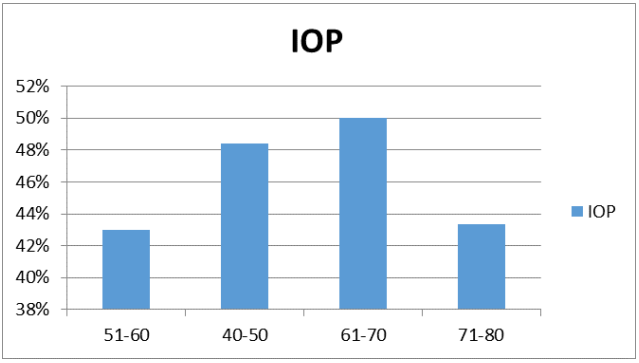
From the result analysis 9 patients found as IOP increased to Border level that is 37.5% and other 62.5% patient found as elevated IOP excess than 20 mmHg.

Comparison found between the IOP mean values according to the age level.

Age limit	Mean value mmHg	Mean value mmHg	Differences	Percentage count
40-50	15	21.5	6.5	43%
51-60	15.5	23	7.5	48.38%
61-70	13	19.5	6.5	50%
71-80	15	21.5	6.5	43.33%

Among the population age limit 61-70 years old patients group showed result as 50% of increased IOP due to YAG capsulotomy. On an average patient data 45% IOP increased during post-surgical check-up when number of laser shot used 30-43.





Result discussion:

In that study age limit selected as 40 to 80 on an average excluding major retinal pre surgical complications like retinal detachment, high intra ocular pressure, glaucoma etc. Total population included 24. On an average pre surgical condition for the age limit 40to 50 years old IOP recorded 15, for the age limit 51 to 60 years old mean IOP value found 15.5,for the age limit 61-70 mean IOP found as 13 and from 71 to 80 mean age value found as 15 during pre-surgical condition. Following PCO capsulotomy with NdYAG laser surgery, the study report from 37.5% of patients indicated that their IOP had climbed to borderline conditions, and another 62.5% of patients reported that their IOP was higher than 20 mmHg. The age group of patients aged 61 to 70 years revealed a 50% increase in intraocular pressure as a result of YAG capsulotomy. When 30-43 laser shots were employed during the postoperative check-up, the average patient's IOP increased by 45%.

Limitations

In this research study 24 patients data analyzed but fort the better assumption more subjects data need to be taken. Beside this when multiple data collected at a time from different health care sectors from different surgeons at the same time will be helpful to find the complications more accurately. Beside this male female ratio is also not performed here. In our literature review we found that the elevated intra ocular pressure value marked as transient that means not stable. If there is no other age related complications then though IOP elevated after 45 minutes to one hour from the surgery, it will begin to lower can be seen within 24 hours after surgery and within one week it should be stable within normal limit or border line in maximum cases. But in this case there are no other further data collected about the intra ocular pressure after 24 hours and one week and no data listed after applying medications. In further studies more data will be taken from multiple health care sector within same time according to same inclusion and exclusion criteria and also further investigations will be included regarding IOP level stability after applying anti-glaucoma medications in time period of 24 hours and one week later.

Conclusion

YAG laser having the wavelength 1064nm, is regarded as a solid laser type that can damage eye tissues and cells. It is included into surgical instruments with the purpose of using the photodisruption principle in the medical domain. It is also referred to as the least invasive and safest surgical method of capsulotomy, which is used in the majority of patients following cataract surgery to remove cell deposition and debris from the posterior capsular portion. The formation of opacification at the posterior capsular region takes around two years, while in younger patients, this time is shorter, and in certain circumstances, older age limits have a lower propensity.

Additionally, it is discovered that, in comparison to non-diabetic instances, diabetic individuals have a lesser propensity to develop posterior opacity capsular opacification. A cloudiness in the membrane's development or the multiplication of epithelial cells that transform into the posterior portion of lens capsules can both lead to posterior capsule opacification. It is possible to remove deposits and opacification following a capsulotomy, improving visual equity in up to 96% of patients. However, if the patient already has a corneal scar, conditions like ARMD, cystoid macular edema, RD, ischemia diseases, etc., they may not only result in higher IOP levels and less improvement in visual aquity following YAG capsulotomy laser surgery.

After surgery, 67% of cases reported fluctuations in IOP of about 10 mmHg. However, after 24 hours and a week, the IOP stabilized to a normal level. In cases where pre-existing glaucoma was present, the effects of an increased IOP were more severe and reduced visual acuity, light sensitivity, and perception. In fact, aqueous humour outflow may be reduced in cases of cell debris, ac cell vitrial cell liquefication, and damage to the trabecular meshwork, which deteriorates IOP regulation and causes high intraocular pressure. Anti-inflammatory drugs and antihypertensive glucoma medications, such as beta blockers, may be useful in those situations to lower the state and bring the blood pressure down to a normal range.

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Chapter - 12

A Review Study on Air Pollution Impacts Affecting Ocular Health & Manifestation

Abstract

Significances

Now a day's environmental pollution levels are increasing and affecting patients especially those suffering from respiratory distress, asthma, dust allergy etc. Short wavelength light rays can be responsible for significant vision impairment and risk factor for the patients using digital screen for a long time period at indoor but also high risk for the patients have longer exposure to the sun. Due to high pollution level and hampered ozone layer in the atmosphere, short wave length lights like UV rays can affect ocular age related changes even cataract and degenerative changes also. In many research studies we have seen that significant number of Age related macular degeneration cases found from the population residing at highly polluted areas. Beside this it also found that inflammatory changes and higher chance for the population located with higher environmental pollution. Healthy diet, avoiding smoking, protective eye wear like UV protected spectacle lenses, UV blocked sunglass or polarized sunglass etc. may lower chances degeneration and impacts due to environmental pollution.

Objectives

- Study and discussion about the complications and impacts occurred due to high environmental pollution.
- Ocular manifestation with degenerative changes.
- Higher refractive errors with astigmatism and dry eye.
- Associated degenerative changes of neurological system and retina.

Aim of study

In this article we have studied previously conducted research articles worldwide from Pub med, research gate, Google scholars etc. and tried to find the ocular manifestation due to air pollution.

Expected outcome

- After study and discussion we have found that Mainly huge amount of industry development responsible for elevating amount of CO2, Nitrogen oxide and all are the reason for global warming with higher environmental pollution level. Beside this indoor pollution level due to smoking may cause harmful effects for other family members as passive smokers. Due to intake of polluted air may increase free radical that can trigger all age related changes. Beside this it also induce cardiac problems, ocular diseases like glaucoma, elevated IOP, Neurological disease with retinal diseases, cancerous changes even death. Many cases also found that severe dry eyes, ocular irritation with reflex watering, redness, inflammatory changes, corneal with conjunctival infections, loss of accommodations, cataract formations etc.
- Patient education is also needful to spread awareness about the air pollution and need to take necessary steps to keep protected from the air pollution avoiding complications and disorders.

Keywords: Pollution, smoking effects, neurological disorders, Retina degeneration

Introduction

Air quality is very essential for all the living healthy life. Air quality deteriorate when increase pollution level and increased amount of dust and harmful gases. Now a day's pollution level is increasing day by day because of industry developments, globalisation, heavy traffic etc. Higher air pollution rate may induce health impacts like respiratory problems, cardiac health issues, skin problems, ocular problems etc. Excessive CO2 emissions from old and expired vehicles, NO_2, sulfur di oxide etc. are responsible for inducing breathing problem and serious health issues due to allergic reactions. Lack amount of tree plantation and excessive forest destruction is also responsible for decreasing pure oxygen level that plays a vital role in air quality control. Air pollution effects and health impacts can be discussed and classified under indoor and outdoor conditions. Due to pollution level ozone layer is damaged so that harmful short wavelength light rays are also coming at ground level that may cause cancer, skin disease, corneal opacity, pterygium growth, UV cataract, higher IOP level etc. Beside this due to bad quality air now a days complain of ocular irritation, dryness, inflammatory conditions and chances, IOP fluctuations etc. also happening. At indoor condition active and passive smoking, excessive near work, digital screen use etc. also responsible for

accommodation anomalies, convergence abnormality, early presbyopia, astigmatism can be occurred. From the recent studies it is also found that various types of retina disorders, age related degenerations, glaucoma tendency, Increasing value of IOP also reported by patients residing permanently at the areas with higher pollution level. In this study we will try to find past activities about the pollution and health impacts including ocular manifestations also.

2.1 Literature review

Globalization, industrialization, and humanity's civilization all invariably lead to air pollution. It is made up of hazardous amounts of a combination of gasses and particles like NO, CO_2 primarily responsible for air pollution at outside that are generated normally by fuel usage and vehicle emissions. It has been demonstrated that exposure to outdoor air pollution is bad for human eyes. Conversely, indoor air pollution caused by cooking, heating, and ambient tobacco smoking etc. also responsible for age related macular disorders and degenerative changes, infections of conjunctiva and corneal surface, tear deficiency with dryness [1]

For all living organisms on Earth to survive and grow, air is necessary. Human health is seriously affected by its quality that have a significant connection with the level of civilization. One most significant causeof worldwide illness load is air pollution. Despite stricter air quality regulations, the number of deaths linked to air pollution has increased in both industrialized and developing nations, including the United States. The majority of air pollution has been dispersed by human technology since the Industrial Revolution, despite the natural fact like volcanoes and wildfires. Global transportation and industrialization have evolved with human civilization.

As industrialization has progressed, there are more fuel-burning companies and motorized vehicles, which has led to excessive air pollution and poor air quality. Particulate matter 2.5 along with other pollutants including SO_2, NO_2, CO_2, NO, and CO are found in the atmosphere and are primarily caused by burning fuel or industrial operations. In addition to transportation and industrial activity, everyday activities like cooking, decorating, and cigarette smoking also release COX and NOX into the air. Negative effects of air pollutants such PM, O3, CO, and NO With the majority of ocular irritation and inflammation, conjunctivitis is a common issue.

The impact of toxins in the environment on the outer surface of the eyes has been the subject of numerous researches. Since the eyes are the most vital

sense organ, air pollution will always have an impact on them first. Thus, during the past three decades, there have been more studies assessing the detrimental consequences of pollution in the air on the eyes. Our evaluation of pertinent studies that are part of this narrative review the most frequent eye condition linked to air pollution was conjunctivitis, or inflammation of the conjunctiva.

The consequences of air pollution on the eyes are described and shown in this article. Here Air pollution, both indoors and outdoors, comes from a variety of sources and can lead to different eye conditions. The most obvious effects of air pollution are dry eye disease, conjunctivitis, and ocular surface irrigation. However, long-term inflammation, oxidative stress, and air pollution poisoning can also lead to the development of cataracts, glaucoma, and uveitis, thinning of the retina, macular degeneration, and diabetic retinopathy [1].

According to research, residing in urban areas with substandard air quality raises the risk of getting age-related macular degeneration (AMD) which may enhance chances of blindness. According to a research study from the British Journal of Ophthalmology, people living in highly polluted areas had an 8% higher chance of receiving a macular degenerative changes diagnosis than people living in less polluted areas.

The area of the retina in charge of central vision Damaged macula AMD develops. We still don't know the exact mechanism underlying this new study's correlation between air pollution and AMD risk, according to a clinical representative for the American Academy of Ophthalmology. We know that pollutants heighten the inflammatory response and that elevated inflammation can raise the risk of dry macular degeneration. One of the signs reduced central vision, which manifests as wavy or fuzzy vision.

People frequently don't detect any changes in their eyesight when AMD is first developing. This is why it's crucial to have ophthalmologists check our eyes on a regular basis. To lower the risk of AMD-related vision loss, you can modify your lifestyle in a number of ways. These healthful routines include quitting smoking, maintaining a balanced diet, and practicing regularly. Among the risk markers we can control are high blood pressure, high cholesterol, and smoking. Early diagnosis is key to efficient treatment of eye illnesses such as wet AMD. We consistently lower our risk of losing our vision thorough ocular examination [2].

Cardiac & respiratory disorders worsen with rising pollution levels. Eye symptoms are less well understood, and they are typically linked to elevated

levels of pollution. People who are affected may experience burning, redness, tearing, a feeling of a foreign body, and blurred vision. Pollution can originate from a variety of gases, including NO2 and ozone, as well as particulate matter from vehicles and other indoor air quality issues. Ocular surface pathogenic processes including oxidative stress, inflammation and toxicity. However, because air pollution is widespread and challenging to manage, evaluating its impact on the eyes is fraught with difficulties. A increased mucosal immune response may be an existing medical condition in those with chronic allergies or atopic predispositions, making them less tolerant to further environment pathogenic stimuli. It is helpful to determine those whose standard of life will be adversely impacted by changes in the environment and to offer protective or therapeutic measures as remedies. Improvements in technology for pollution monitoring and visual evaluation will help this profession advance [3].

Threats to human wellness and death in the twenty-first century include pollution and climate change. Cardiovascular and respiratory conditions worsen with increasing pollution levels. Eye symptoms are less well understood, and they are typically linked to elevated levels of pollution. People who are affected may experience burning, redness, tearing, a feeling of a foreign body, and blurred vision. Pollution can originate from a variety of gases, including NO_2 and ozone, as well as particulate matter from vehicles and other indoor air quality issues like ocular surface pathogenic processes including oxidative stress, inflammation, and toxicity.Given that prolonged exposure to indoor pollution is linked to respiratory and heart disease, as well as higher hospitalization rates and healthcare expenses, air pollution poses a severe threat to public health with affecting daily lifestyle. These tendencies have been observed in both Asia and the Westand it is anticipated that as cities grow, these issues will get worse. Pollution can, in extreme circumstances, even raise death rates.

The World Health Organization, or WHO, defines air pollution as the presence of harmful fragments, such as particulate matter, ozone, CO_2, NO_2, and SO_2. Watery eyes, red eyes, and discomfort are all ocular manifestations reporting by patients due to polluted environment. Eye doctors occasionally fail to consider the environmental factor. Our goal is to review the literature on works published during the previous ten years. Applying keywords such as eye surface, pollutants, dry eyes, conjunctiva, and cornea, the search method retrieved pertinent English papers that appeared in Entrez PubMed between November 2007 and January 2017. The scope of previous reviews was different and they were not incorporated into the current study. Ocular surface

contamination involvement as summed up by five population surveys. Since whole towns and cities are included in this research, it is challenging to determine which ecosystems within a given geographic area are comparatively more harmed by pollution. These five studies were picked primarily because they focused on the effects on the eyes and because the circumstances of long-term exposure to the pollutants were typical of the areas in which they were conducted. Because of this, the research that follows will examine multiple methods for figuring out how the environment impacts the ocular surface. The primary issue is the availability of many scoring questionnaires to measure dry eye symptoms, such as the Symptom Assessment Act Dry Eye, the General Patient Assessment of Dry Eye, and problems affecting the outer surface of the eye.

These surveys evaluate the frequency of irritated eyes, dry eyes, weeping, or impaired vision that people report. This uniform survey makes it easier to understand. Toxicology, oxidative stress, and inflammatory via gas and minute particles in the atmosphere are a few of the processes that result in issues with the surface of the eyes. Studies involving humans are limited since it is exceedingly challenging to regulate and standardize air pollution. Polluted cities have a wide range of biological and environmental issues, some of which may not even be connected to pollution. People might, for instance, lead more hectic lives or have fewer hours for healthy eating and exercise. Genetic variations and seasonal influences like exposure to air pollen are other possible complicating factors. Furthermore, extensive population studies the outermost layers and structure of the eye are affected most due to air pollution that may significantly lower quality of life and cause noticeable morbidity in those who are susceptible to immunological triggers [5].

The eyes are impacted by air pollution. Air pollution effects might range from mild to nonexistent to causing long-term discomfort and irritated eyes. For instance, people who wear contact lenses may potentially have specific situations where air pollution negatively affects their eyes. Eye doctors frequently neglect the eye effects of pollution in the air when assessing their patients, despite the fact that air pollution is present in many both indoor and outdoor contexts. This essay will go over the background information needed to comprehend how air pollution affects the eyes. Guidelines for treating air pollution-related ocular problems are given [6].

Pollution of the air is a major global health issue linked to several illnesses, such as cancer and neurological disorders. The burning of fossil fuels, automobiles, industrial development and forest fires are the mainly responsible for air pollution. Harmful levels of pollutants, such as PM 2.5,

continue to afflict both industrialized and developing nations despite air quality rules. The majority of people on the planet breathe air that is more polluted than what is recommended by the WHO, with countries with low to middle incomes being most exposed.

Chronic renal illness, Type 1 diabetes, heart disease, premature birth, and other systemic problems are linked to PM 2.5, which can reach the circulatory system and lungs. According to recent studies, there may be a connection between glaucoma, age-related macular degeneration (AMD), uveitis, dry eyes, cataracts, and PM 2.5, an air pollutant. Since glaucoma is a significant cause of blindness in the world that is more common in cities, there may be a connection between it and air pollution. Air pollution-related illnesses have been linked to inflammatory pathways and micro vascular alterations, while the precise processes behind the onset of glaucoma are yet unknown.

Though some studies reveal moderate rises in the pressure inside the eye and others find no significant changes, the association among pollution in the air and intraocular pressure is still unclear. The intricate interactions between particulate matter, air pollution, and IOP control in the setting of glaucoma require more study. We need to learn more about how particulates affect eye health since due to environmental pollutions affect and its negative impact on millions of people worldwide [7].

Ophthalmologists are aware of the many influences on vision and the general health of the eyes. When patients complain of dry eyes at an eye clinic, ophthalmologists frequently cite aging, dry air, a growing number of digital gadgets, or systemic drugs as contributing reasons. An ophthalmologist who works in the area surrounding New York City believes that air quality is an important cause for dry eye. I have been working with a number of patients for the past year who take weeks or months at a time to go to places with better air quality. A lot of them reported experiencing stinging, burning, tearing, and variations in eyesight shortly after returning home.

Conversely, I treat a number of patients who visit locations that are significantly affected by pollution if compare with New York City then come back home experiencing similar symptoms, if not worse. Air contamination one way to characterize pollutants is as a complex mixture of biological components, chemicals, and particles.1. People cannot pick the type of air to breathe, unlike the food or water they consume, hence it is difficult to prevent its negative effects.

As per last updated report by American Lung Association said about that at least 125 million Americans residing in counties with dangerous air quality.

According to the US Environmental Protection Agency, ground level ozone, particle matter, carbon monoxide (CO), lead sulfate dioxide, and nitrogen dioxide are the six most prevalent air pollutants[8].

Previous research indicates a connection between human eye problems and air pollution. There are no studies looking into how air pollution affects non-acute conjunctivitis. This research looked into the connection between Taiwanese pollution in the air and medical care for undifferentiated conjunctivitis. To investigate and evaluate the possibility of short-term impacts of particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, and particulate matter in nonspecific conjunctive inflammation a multi-area investigation was carried out .Seven air quality measuring regions' worth of outpatient visits with nonspecific conjunctivitis provided the data. An immediate and lag study of the effects of pollution in the air was conducted using a region-specific case-crossover analysis and the results were combined using a systematic review with random effects. Air contaminants such as SO_2, O_3 and NO_2 may not have noticeable late effects and an increased likelihood of going to the doctor for unexplained conjunctivitis[9].

A health provider's perspective indicates that O_3, carbon monoxide, SO_2, nitrogen oxides, volatile organic substances, and particle matter are among the hundreds of components that make up air contaminants. Research on the connection between air pollution & human well-being has been conducted for many years. Human health is negatively impacted by both acute and long-term factors. It can impact almost every system in the human body.

There has been a lot of data showing that air pollution can have detrimental effects on a person's neurological and respiratory systems as lots of developmental issues are also associated with the environmental pollution factors. As eyes are also significantly associated with brain and spinal cord (CNS). But in the field of environmental medicine, the eyes are frequently an underutilized organ.

The majority of people believe that the health effects of air pollution for their eyes are restricted to minor irritation on the surface of the eyes; nevertheless, the truly pollution effect can make a greater impact on the eyes is far more than we realize. To emphasize the intricacy of the connections of air pollution to ocular health, the writers of this paper evaluated all the short- and long-term health impacts about gaseous particle like airborne pollutants over the eye health [10].

Global air pollution increases in tandem with population growth and

industrialization. There are numerous more concerns to be conscious of, especially those that damage the eyes, even though respiratory issues are among the most prevalent health issues linked to pollution. Any component of the body might be impacted by air pollution. This can cause major illnesses that can be fatal, including heart difficulties, lung cancer, respiratory diseases, and strokes. Changes in the weather and smoke from wildfires are two factors that might impact the quality of the air. Additionally contributing factors are gasoline fumes and UV radiation exposure, which can irritate and sicken everyone in their path. However, breathing problems aren't the only effects of pollution in the air; it can also harm your eyes. Additionally, it can occur for varied lengths of time and intensity.

The eyes are among the many health regions that are impacted by pollution in the air. Air pollution directly affects the tissues and structural elements of your eyes. This covers the sclera, cornea, and eyelids and the eye's native lens. Every one of these components is susceptible to strong irritants present in the external and internal surroundings. You might feel uncomfortable, get inflammation, have trouble seeing, and have other symptoms if exposed. It's critical to understand these allergens, what might irritate your eyes, and both short- and long-term management techniques.

Your eye health can be impacted by a variety of air pollution factors, including as humidity, sun exposure, and air quality. Typical types of pollution in the atmosphere including the following: Air pollution can happen outside as well as indoors.-dust, pollen, wind, and dry air. It's possible that some places irritate more than others. For instance, the air near beaches might be saltier, and the air around volcanic activity might be more smokey. Smoke injury to the eyes is more common in industrial locations and places with frequent fires.

Because they are dryer compared to other climes, desert-like settings might irritate people even more. Air pollution can cause the following short-term issues: of the eye Deterioration of allergies and allergic conjunctivitis there is a lot of risk. Dry eyes, particularly Contact lenses Forburning, other irritants, itching, and impaired vision. Teary eyes. These side effects may result in long-term issues if untreated.

Long-term eye problems such as dry eyes condition, Meibomian gland disorder, blepharitis, glaucoma, cataracts, and trachoma that can all be brought on by exposure to air pollution. Dry eye is directly caused by environmental factors such wind, dust, and dryness. Over time, dry eye can become chronic. Not only does living in or frequently coming into contact with a dry

environment exacerbate the issue, but it can also increase your eyes' susceptibility to irritation from pollutants.

Dry conditions as well as annoying airborne particles like dust and pollen might have an impact on tear film. It may result in issues such as inflammation of the little glands in the eyelids that produce tears, and dysfunction of the meibomian glands. There is also a chance of blepharitis [11].

Every year, air pollution causes about 6.7 million premature mortalities worldwide. It has been linked to the possibility of autoimmune and intestinal disorders, as well as non-communicable illnesses such lung cancer, different types of obstructive lung disorder, stroke, and cardiovascular disease. There has been an increase in pollution from the air during the last 20 years. Air pollution is produced by fuel from automobile combustion, burning solid fuels at home, industrial operations (such as mining, manufacturing, and construction), and natural causes (such as dust storms, pollen, and bushfires). Gases including carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen dioxide, ozone etc. are like air pollutants examples. One of the body parts most susceptible to airborne contaminants is the eye, because of its close interaction with the outside world. There is ample evidence about how air pollution affects the surface of the eyes. However, there's growing evidence that air pollution has an impact on the retina.

Retinal & choroidal blood flow can be impacted by air pollution exposure, which can result in retinal vascular occlusion. Moreover, it might be linked to a higher risk of age-related macular degeneration and glaucoma. There are varying correlations between various air contaminants and poor quality of life, visual impairment, and ocular illness.

Since air pollution is becoming a more widespread issue, it is critical to comprehend how it affects eye health and vision impairment in order to create public health initiatives that will reduce ocular morbidity. Our goal is to examine and summarize current research on how air pollution affects illnesses of the posterior region of the eye, specifically how it may be affecting as a significant risk factor regarding age-related macular degeneration, glaucomatous changes and disorders with other retinal vascular disease [12].

By 2050, half of humanity will be affected by myopia, most prevalent types of refractive disorders. Myopia has emerged as a primary cause of vision impairment in the last few decades, and its onset and progression are thought to be related to a number of variables. Environmental factors specially air pollution that has received increasing attention recently since it impacts the dopamine system, induces retinal ischemia, and enhances peripheral

hyperopia defocus when exposed to ambient air pollution. In this review, we emphasize the biological mechanisms and epidemiological evidence that could connect exposure to air pollution with myopia. Developing and putting into practice specific strategies require a deep grasp of these processes. About this burden on global public health, regulatory actions to regulate and control air pollution level within the healthy parameters by taking several initiatives. Particulate matter and gaseous components that remain in the air combine to form a complicated mixture known as air pollution. Ozone, nitrogen oxides, and carbon monoxide are examples of air pollutants.

Because there haven't been many thorough evaluations on the subject to date, we provide an overview of the data that is currently available about the connection among air pollution and myopia. Our goal is to investigate the fundamental physiological processes in order to stimulate more study and give governments more understanding of their clean-air regulatory initiatives [13].

Air contaminants come in a variety of forms, including gases, particles, and organic compounds. These include particulate matter, atmospheric sulfur dioxide, atmospheric nitrogen dioxide, carbon dioxide and nitrogen oxides. Additionally, these chemicals' interactions may irritate your eyes. These oxidants have the ability to disintegrate and acidify the tear film, irritating the eye's mucous membrane. Indoor air pollution is also a problem. Indoor air pollution is caused by a number of factors, including inadequate ventilation, smoking, formaldehyde, cooking and decorating in the home, heating systems, and household decorations.

Outer ocular surface specially cornea susceptible to the adverse effects by the pollutants in the air media and may be the first organ to be harmed because of its frequent exposure to both indoor and outdoor environments. But environmental toxicity, oxidative stress, and persistent inflammation can overcome tear film health against contaminants. According to studies, conjunctivitis was among the most prevalent eye condition linked to air pollution. Retinopathy, glaucoma, dry eye disease, and ocular surface disease have all been related to outside pollution. Additionally, uveitis and cataracts have been connected to indoor pollution. Furthermore, air pollution from traffic is associated with a higher risk of macular degeneration related to age, according to an investigation released in the Journal of Experimental Medicine.

The impacts of the environment on the eye need to be better understood especially in light of the progressively more extreme weather patterns that fuel natural disasters like wildfires. Only a few numbers of

research have looked into the connection between eye disease and air pollution to yet. As a result, it is currently unknown how long-term exposure to air pollution would affect eyesight. To better understand patterns of exposure and ocular impacts, more study on the connection between air pollution and ocular illnesses is required [14].

Conclusion

From above discussion we can find the significance of air quality control and health impacts from poor air quality. Beside the eye check-up campaign it is also necessary to spread awareness among the population to take necessary steps to avoid or prevent pollution. Regular health and eye check-up also important to follow up the health conditions and refractive error correction with necessary coated lenses for protective purpose.

Various studies on medical aspects are related to eyes and health. Research on air pollution and ocular surface contamination, however, is scarce from an applied standpoint. Finding the link between air pollution, particularly particulates, and other outside variables that irritate the eyes is the primary goal of the study. Testing current models to simulate the human eye is a secondary objective of the effort. An exposure-based probing was assigned tags according to their actions in a workshop survey questionnaire that followed the investigation. This study shows a connection among particulate matter and health problems in humans, including a host of eye conditions like trachoma, myopia, glaucoma, dry eye, and conjunctivitis. According to the questionnaire survey results, 68% of workshop workers reported experiencing symptoms like tears, impaired vision, and fluctuating emotions, while 32% reported no symptoms at all. The test protocols exist, but the evaluation is not clearly specified; the deposit of particles on the eye necessitates scientific and numerical solutions [4].

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