

Cataracts Pathophysiology and Managements

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ABSTRACT

Background: Cataract is defined as the loss of lens transparency because of opacification of the lens. Age-related cataract is the most prevalent type in adults, with the onset between age 45 to 50 years, while in children hereditary and metabolic causes are most common.

Aim of the work: In this study, our aim was to discuss the epidemiology, pathophysiology, classification, risk factors, symptoms, and management of cataracts.

Methodology: We conducted this review using a comprehensive search of MEDLINE, PubMed and EMBASE from January 1981 to March 2017. The following search terms were used: cataracts, causes of cataract, pathophysiology of cataract, management of cataract.

Conclusion: Cataract is one of the most common causes of blindness worldwide, and more prevalent in developing countries. It is also the most curable cause of blindness which involves a simple surgical procedure.

Keywords: cataracts, causes of cataract, pathophysiology of cataract, management of cataract.

INTRODUCTION

Cataract is defined as the loss of lens transparency because of opacification of the lens. Based on the causes, cataracts can be classified into age-related cataracts, pediatric cataracts, and cataracts due to other causes. Age-related cataract is the most prevalent type in adults, with the onset between age 45 to 50 years, while in children hereditary and metabolic causes are most common. Cataracts occurs more frequently in low to medium socioeconomic background individuals, and therefore more common in developing countries^[1]. The assessment and management of cataract is rather simple where the lens is surgically replaced. In this review, we discuss the epidemiology, pathophysiology, classification, risk factors, symptoms, and management of cataracts.

METHODOLOGY

• Data Sources and Search terms

We conducted this review using a comprehensive search of MEDLINE, PubMed and EMBASE, from January 1981 to March 2017. The following search terms were used: cataracts, causes of cataract, pathophysiology of cataract, management of cataract.

• Data Extraction

Two reviewers have independently reviewed the studies, abstracted data and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

This study was done after approval of ethical board of King Abdulaziz University.

Epidemiology

WHO assessed that around 95 million people are visually impaired because of cataracts in 2014. Numerous large-scale population-based studies have described that the prevalence of cataract rises with age, from 3.9% at age 55 to 64 years to around 92.6% at age over 80 years. Moreover, the presence of cataracts is related with increased mortality, and this association might be because of the relationship between cataracts and systemic conditions for example type 2 diabetes mellitus or smoking^[1].

The prevalence of cataracts in the past two decades has been decreasing because rates of cataract surgery have been increasing due to the improved techniques. Nevertheless, cataracts continue to be the leading cause of blindness in middle-income and low-income countries responsible for 50% of blindness, while they are accountable for only 5% of blindness in developed countries. It is imperative to device a set of policies to improve the access of effective ophthalmic facility and screening, and the quality of management delivered in developing countries^[2].

Cataract surgery continues to be one of the most cost-effective treatments and the most frequently used procedure in many countries. By 2020, over 30 million people yearly worldwide are predicted to experience cataract surgery. The

socioeconomic outcome of cataract surgery is large. It permits people to increase their economic yield by up to 1500% of the cost of the surgery through the first postoperative year, nevertheless if left untreated it can result in a patient being removed from work. In the USA, the yearly expenditure on cataract surgery is US\$3.4 billion, although in rural China, the cost for a cataract operation can be two times a patient's annual income. Amount of annual cataract surgeries differ among countries because of variances in accessibility for diagnosis referral, surgery, and health-care systems. There is also gender disparity in cataract treatment coverage in low and middle-income countries, where men are more probable to have cataract surgery compared to women (odds ratio of 1.71, 95% CI 1.48–1.97)^[3].

Pediatric cataracts are one of the most frequent causes of treatable juvenile blindness, with an estimated prevalence reaching from 1-6 per 10,000 live births. Congenital cataracts are responsible for the majority of pediatric cases and 5–20% of childhood blindness globally, but 22–30% of childhood blindness occur in developing countries^[4].

Pathophysiology

The lens is a transparent biconvex object, which causes refraction and focuses light onto the retina. The human lens is composed of fibers, enclosed by a thin capsule, and is maintained by zonules on both sides. The lens fibers are made from the lens epithelium and migrate from the margin towards the center. Henceforth, the nucleus of the lens is derived from older lens fibers, and newly formed lens fibers are positioned in the outermost layers of the lens, which is known as the cortex^[5].

Opacity of the lens is a direct outcome of oxidative stress. Based on location of opacification within the lens, age-related cataracts are classified into three types: cortical, nuclear, and posterior subcapsular cataracts. The lens epithelial cells are highly metabolically active cells of the lens, undergoing oxidation, crosslinking, and insolubilization. These cells later migrate to the lens center to form lens fibers that are progressively compressed and results in lens nuclear sclerosis leading to opacity. A cortical cataract is frequently wedge-shaped, starting at the cortex and covering to center of the lens. A plaque-like opacity grows in

the axial posterior cortical layer in posterior subcapsular cataract. In most patients, over one type of cataract is found^[6].

Congenital cataracts denote a lens opacity that manifests at birth, while infantile cataracts imply a lens opacity that grows during the first year of life. Pediatric cataracts can be unilateral or bilateral, which depends on the cause. Roughly a third of pediatric cataracts are hereditary, one-third coexist with other ocular anomalies indicating a part of a multisystem syndrome, and another one-third have undetermined reasons. Pediatric causes of cataracts include^[7]:

- Idiopathic
- Ocular anomalies
- Anterior segment dysgenesis syndrome
- Aniridia
- Posterior lenticonus
- Persistent fetal vasculature
- Posterior pole tumors
- Hereditary
- Multisystem syndrome
- Down's syndrome
- Trisomy 13–15 syndrome
- Lowe syndrome
- Marfan's syndrome
- Fabry disease
- Alport syndrome
- Myotonic dystrophy
- Maternal infection
- Rubella
- Syphilis
- Cytomegalovirus infection
- Toxoplasmosis
- Varicella
- Metabolic disorders
- Galactosemia
- Wilson's disease
- Hypoglycemia
- Galactokinase deficiency
- Hypoparathyroidism
- Toxic effects
- Radiation exposure
- Corticosteroids
- Trauma

Cataract can be induced by drugs. Long-term usage of corticosteroids, regardless of route of administration, is strongly linked with posterior subcapsular cataract development. Other

medications known to encourage cataract development comprise phenothiazines, busulfan, miotics, and amiodarone. The link between the use of statins and cataract is still debated. Other causes of cataract comprise mechanical trauma, electrical injury, chemical injury, and ionizing, ultraviolet or infrared radiation. Changes of the lens also frequently happen secondary to chronic uveitis, Fuchs' heterochromatic uveitis, and pseudo exfoliation syndrome^[8,9].

Risk Factors

The risk factors for cataract development can be classified as^[10-12]:

- Non-modifiable factors
 - Age
 - Female sex
 - Low educational or socioeconomic status
 - Racial or ethnic groups:
 - White people have higher prevalence
 - People of Asian ethnic origins have higher prevalence than European
 - Genetic factors:
 - Gene polymorphisms (rs3754334, XRCC1 Arg399Gln, KLC1, APOE, GSTT1, and XPD Lys751Gln) may have roles in predisposition to age-related cataract
 - Chromosome 3 in KCNAB1 and chromosome 21 in CRYAA
- Lifestyle factors
 - Cigarette smoking
 - Alcohol consumption
 - Ultraviolet-B exposure
- Systemic medical problems
 - Type 2 diabetes mellitus (cortical cataract and posterior subcapsular cataract)
 - Metabolic syndrome (mixed lens opacities)
 - High systemic blood pressure (posterior subcapsular cataract and mixed lens opacities)
 - Moderate to severe renal impairment
 - Hypocalcemia
- Diet
 - Malnutrition
 - Ingesting of carbohydrates with high-glycemic index
- Ocular disorders
 - Large retinal drusen (mixed lens opacities)
 - Myopic refractive error (nuclear opacity)
- Protective factors
 - Increased consumption of vegetables

- Vitamin E, carotenoids, vitamin B or A, or antioxidant supplements
- Continuing a protein intake of 100–150 g/day and vitamin C intake of roughly 135 g/day

Heritability of nuclear cataracts varies from 36% to 48%, while genetic factors are reason for 35% of the differences in progression of nuclear cataracts. Nevertheless, in contrast with congenital cataracts, information about genetic predisposition factors in age-related cataract is relatively rare^[13].

Roughly 50% of congenital cataracts have a genetic origin. Autosomal dominant transmission is the most common, but it can likewise be autosomal recessive or X-linked. Over 20 genetic loci have been recognized, and most are related to genetic mutations relating to lens development. These susceptibility loci comprise the α , β , and γ crystallin, connexin, lens cytoskeletal protein, growth and transcription factor, membrane junction protein, and ferritin light chain genes^[14].

Symptoms

Various types of cataracts have dissimilar effects on visual symptoms. Patients frequently complain of blurry vision, glare and haloes from lights. Nuclear cataracts usually affect distance vision greater than near vision, while posterior subcapsular cataracts regularly decrease near more than distance visual acuity.

Progressive nuclear sclerotic changes lead to intensification in the lens refractive index. This increase implies that the cataract lens can refract light more, and hereafter the eye converts to more myopic. If this refractive index is not adjusted with glasses, then the patient acknowledges deterioration in far vision and paradoxically some enhancement in near vision. Glare is predominantly common in patients presenting with posterior subcapsular cataracts. Patients may also complain of monocular diplopia because of localized variations in the refractive index of the lens. Some patients can only have visual trouble when doing daily activities for instance reading or driving causing visual disability^[5].

Management

The current mode of management of a visually significant cataract is to surgically remove the disabled lens and replace it with an intraocular lens. Cataract surgery is specified when the patient

experiences vision loss of enough severity for them to agree to take the potential risks of surgery. Cataract surgery is not indicated for prevention^[15]. The consequence of cataract surgery is not dependent of preoperative visual acuity. In spite of the developments in surgical technology and procedures in the past decade, good surgical outcomes still include thorough preoperative evaluation, precise intraocular lens power assessment, and proper intraoperative and postoperative management. Topical steroids, antibiotics, or non-steroidal anti-inflammatory drugs are used for 1–4 weeks following a surgery^[16].

CONCLUSION

Cataract is one of the most common causes of blindness worldwide, mostly age related. It can also affect children with metabolic abnormalities and some other genetic cause. Cataract is more prevalent in developing countries. It is also the most curable cause of blindness which involves a simple surgical procedure.

REFERENCES

1. **Murthy G, Gupta SK, John N, Vashist P(2008):** Current status of cataract blindness and Vision 2020: the right to sight initiative in India. *Indian J Ophthalmol.*, 56: 489-494.
2. **Abraham AG, Condon NG, West Gower E(2006):** The new epidemiology of cataract. *Ophthalmol Clin North Am.*, 19: 415-425.
3. **Dawson CR, Schwab IR(1981):** Epidemiology of cataract - a major cause of preventable blindness. *Bull World Health Organ*, 59: 493-501.
4. **Wu X, Long E, Lin H, Liu Y(2016):** Prevalence and epidemiological characteristics of congenital cataract: a systematic review and meta-analysis. *Sci Rep.*, 6: 28564.
5. **Gupta VB, Rajagopala M, Ravishankar B(2014):** Etiopathogenesis of cataract: an appraisal. *Indian J Ophthalmol.*, 62: 103-110.
6. **Chylack LT, Jr.(1984):** Mechanisms of senile cataract formation. *Ophthalmology*, 91: 596-602.
7. **Hejtmancik JF(2008):** Congenital cataracts and their molecular genetics. *Semin Cell Dev Biol.*, 19: 134-149.
8. **Medsinge A, Nischal KK(2015):** Pediatric cataract: challenges and future directions. *Clin Ophthalmol.*, 9: 77-90.
9. **Nguyen TV, Pham VH, Abe K(2015):** Pathogenesis of Congenital Rubella Virus Infection in Human Fetuses: Viral Infection in the Ciliary Body Could Play an Important Role in Cataractogenesis. *EBioMedicine*, 2: 59-63.
10. **Mukesh BN, Le A, Dimitrov PN, Ahmed S, Taylor HR, McCarty CA(2006):** Development of cataract and associated risk factors: the Visual Impairment Project. *Arch Ophthalmol.*, 124: 79-85.
11. **Age-Related Eye Disease Study Research G(2001):** Risk factors associated with age-related nuclear and cortical cataract : a case-control study in the Age-Related Eye Disease Study, AREDS Report. *Ophthalmology*, 108: 1400-1408.
12. **Glynn RJ, Rosner B, Christen WG(2009):** Evaluation of risk factors for cataract types in a competing risks framework. *Ophthalmic Epidemiol.*, 16: 98-106.
13. **Haargaard B, Wohlfahrt J, Rosenberg T, Fledelius HC, Melbye M(2005):** Risk factors for idiopathic congenital/infantile cataract. *Invest Ophthalmol Vis Sci.*, 46: 3067-3073.
14. **Rahi JS, Dezateux C(2000):** Congenital and infantile cataract in the United Kingdom: underlying or associated factors. *British Congenital Cataract Interest Group. Invest Ophthalmol Vis Sci.*, 41: 2108-2114.
15. **Dickson R, Eastwood A, Gill P, Melville A, O'Meara S, Sheldon T(1996):** Management of cataract. *Qual Health Care*, 5: 180-185.
16. **Allen D, Vasavada A(2006):** Cataract and surgery for cataract. *BMJ.*, 333: 128-132.