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Risk Factors Which Lead to Development of Senile Cataract: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Maturing processes, including those brought about by various outside factors, have stood out for researchers throughout the last years. Senile cataract is a multifactorial illness. The expense of surgery of cataract medical procedures stays among the highest costing procedures in general public healthcare. Age is an essential element that causes senile cataract morbidity, which double ten every ten years. This article considers some sources which portray research results on impact on cataract development by risk factors like age, sex, race, smoking, alcohol consumption, diabetes (pancreatic), usage of specific drugs, various environmental aspects, including ultraviolet and ionizing radiation; many of which are shown to cause increment or decrease the risk of senile cataract; there is clashing information on specific factors. Depending on etiology, experts spot senile, congenital, traumatic, complicated, and occupational cataracts. Senile cataract (hereafter referred to as "cataract") is the most prevalent. The layout also contains quantitative data of cataracts and risk, given through odds ratio and advance because of age, alcohol consumption, ionizing radiation, etc. The researchers also express that there is still no finding on whether the dose-effect relationship for cataract evolvement is a non-threshold or threshold. Surgical procedures are the only treatment available. The surgical procedure usually needs less than an

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hour. The surgeon makes a small incision in the sclera or limbus of the eye, sometimes with a laser. A small tool is put in to break up the cataract and gently suction it out through the opening created. Then they put in the new lens, made of plastic, silicone, or acrylic, and close the incision. Surgical procedures namely phacoemulsification and minor incision cataract surgery (SICS) are widely used for cataract surgeries; the former is the latest development in cataract surgeries and is less time-consuming. If both eyes are affected, two surgeries are done separately.

Keywords: Senile cataract risk; multi-factor disease; factors; odds relation; relative risk; dose-effect relationship; age parameters.

1. INTRODUCTION

A cataract is any persistent opacity occurring in the lens substance or capsule. A cataract is a significant medical, social and economic issue in many countries [1-3,4], leading to disorders of vision and blindness (33%) in the world [1,2]. Expenditure on cataract surgeries contributes to overall public health care expenditure considerably. Depending on etiology, experts spot senile, congenital, traumatic, complicated, and occupational cataracts. Senile cataract (hereafter referred to as “cataract”) is the most prevalent.

There are three main types of cataracts based on clinical and anatomical features: cortical, nuclear, and back sub-capsular, and they can occur both separately and in combinations [5]. Nuclear cataract the acidification of the central part (nucleus) of the lens, which is combined with sclerosis of lens fibers, the nucleus color is changing to yellowish or even brown, and overall eyesight deterioration. Cortical cataract involves opacification of the peripheral part of the lens. With the progression of age, opacities appear in the cortical area of the lens (spoke-like or sectoral), which usually don’t lead to any clinical symptoms until the lens optical axis area is involved in the process. The back subcapsular cataract (BSC) constitutes a compact opacity located in the posterior area of the central cortex under the capsule. It usually occurs in younger age groups and causes a considerable loss of near vision activity.

Results obtained from considerable research on reasons for cataract evolvement revealed that cataract was a multi-factorial disease. The evolvement of cataracts depends on age, sex, race, concomitant somatic or eye pathology, addictions (smoking), nutritional peculiarities, as well as environmental factors, like exposure to ultraviolet radiation and ionizing radiation and intake of certain medications [4,6]. This literature review explains the possible cause of some of the risk factors affecting cataract development and compares the risk factors to find the most important and least important ones. It also helps us to find the avoidable factors.

Objective: This review article outlines the risk factors of senile cataracts. It also draws a rough comparison among the risk factors to have an idea of the most important and least important factors through statistical data, a. This would help doctors have a rough idea of a patient being exposed to such factors and ease the diagnosis process. From a social perspec,tive it would bringexpenseshe people's expenses of cataract surgeries by reducing their incidence.

Methodology: To comprehend this review article, various literature searches were done usiPubMeded, google scholar, and from various ophthalmology journals like INDIAN JOURNAL OF OPHTHALMOLOGY in a very aggressive manner.

2. NON-RADIATION FACTORS

2.1 Age

Age is the basic factor leading to an increased risk of cataracts. Thus, the prevalence of cataracts among people of age group 52-62 is 5% [7]; among people of age group 60-69 is 30%, and among people older than 70 years is 64% [8]. The fact that cataract-associated morbidity doubles every ten years after the age of 40 implies that all people belonging to the age group 80-90 suffer from cataracts [9]. The pact of oxygen free radicals on lens tissue is considered the main reason for opacification of the lens, which is a characteristic of senile cataracts. A group of researchers found that age had a statistically significant influence on cataract evolvement of all types. Odds Ratio (OR) per each 10 years of life amounted to 9.90 (95% CI: 8,20 – 11,90) for nuclear cataract; 3.06 (95% CI: 2,76 – 3,40) for cortical cataract; 3.09 (95% CI: 2.71 – 3.51) for back sub-capsular cataract; and 6.62 (95% CI: 5.78 – 7.63) for all cataract types.

2.2 Sex

After much epidemiologic research, researchers concluded that cataract risk was slightly higher for women than for men; however, the dependence remains unclear. The work [10] contains data on OR for morbidity with cataracts among women, which was 3.03 (95% CI: 1.83 – 5.00) against men. Another research [11] showed that cataract frequency was slightly higher among women than men, or 1.55 (95% CI: 1.26 – 1.91). Third, research performed as per the “case-control” type revealed only a boundary dependence between sex and cataract [12]. Some researches throw light on the substitutive hormonotherapy in women during a period after menopause [13,14].

2.3 Race

Some researchers state a correlation between various cataract types and patients’ race. S.K. West, B. Munoz et al. [15] revealed that the risk of African Americans developing cortical cataracts was four times higher than White Americans while White Americans were more at risk of developing nuclear or back sub-capsular cataracts. Another research revealed that cortical cataracts prevailed among Latin Americans [16].

2.4 Smoking

Some researches showed a correlation between smoking and lens nuclear sclerosis and detected a dose-effect dependence; people who gave up on smoking were under a lower risk of o developing cataracts than those who continued to do so [17-20]. So, there was a protective effect of giving up smoking.

Another research [21] showed that smokers had higher morbidity with nuclear cataract (OR = 2.06; 95% CI: 1.46 – 2.98), with cortical cataract (OR = 1.33; 95% CI: 1.02 – 1.74), with back sub-capsular cataract (OR = 1.39; 95% CI: 1.02 – 1.91), or with any cataract type (OR = 1.48; 95% CI: 1.10 – 1.99) after corrections as per age, sex, body mass index, arterial hypertension and diabetes. At the same time, another study [22] found no evidence of such dependency. Education up to elementary or secondary level (OR = 1.67; 95% CI: 1.06 – 2.64) and low monthly income increased nuclear cataract risk while living in a small apartment increased back subcapsular cataract risks (OR = 1.70; 95% CI: 1.28 – 2.25). Men who smoke have a 17.9% chance of developing nuclear cataracts, and it has been proven that a) smoking causes a statistically significant rise in senile cataracts (all types) independent of age, sex, body mass index, hypertension, and diabetes; b) morbidity with nuclear cataract was related to how many cigarettes a patient smoked in a day, and it increased with increasing smoking index. If this addictive habit is avoided or reduced, it can reduce the chances of cataract.

2.5 Alcohol Intake

The essence of the influence of alcohol on cataract genesis is still unknown. The lens is vulnerable to oxidative stress caused by alcohol and the direct toxic effects of alcohol and its metabolic products [23–25]. However, the data for a link between alcohol consumption and senile cataracts is controversial. Beer abusers [26] and past alcoholics [27] had statistically significant higher cataract risks, according to "case-control" research findings. Two cohort examinations [28,29,30] indicated a positive but statistically insignificant link between alcohol consumption and cataract progression. Strong alcohol and wine consumption were linked to an increased risk of nuclear opacities, according to experts studying certain cataract types (OR = 1.13; 95% CI: 1.02–1.26), whereas risks of cortical opacities were reduced on wine consumption (OR = 0.88; 95% CI:0.79–0.98) [31]. A statistically significant positive connection between alcohol consumption and the likelihood of "operated" cataracts were discovered in a population prospective cohort study [14]; the risk grew with an increase in overall consumed alcohol volume; relative risk of "operated" cataract amounted to 1.11 (95% CI: 1.02 – 1.21) after corrections as per age and other potential risk factors. Avoiding or reducing alcohol intake can reduce probability of cataracts.

3. SOMATIC PATHOLOGY

3.1 Pancreatic Diabetes

Pancreatic diabetes of both types (1 and 2) is one of the most significant somatic disorders that lead to increased cataract evolvement risk. In comparison to persons who did not have such a pathology, the odds ratio for cataract progression in people with pancreatic diabetes was 2.72 (95% CI: 1.72 – 4.28) according to research [11]. Another study [32] found that a dextrose level of less than six mmol/l in blood obtained on an empty stomach induced a higher risk of cataracts (OR = 1.79; 95% CI:1.25 – 2.57 against the

dextrose level < 6 mmol/l). The same study found that one mmol/l increase in dextrose levels in blood obtained on an empty stomach was linked to 5-year advancement in rear sub-capsular cataract (OR = 1.25; 95 percent CI: 1.15–1.35), as well as 10-year progress in cortical (OR = 1.14; 95 percent CI: 1.01–1.27) and nuclear cataracts (OR = 1.20; 95 percent CI: 1.01–1.43), with no threshold found. Furthermore, it was discovered that cataract surgery on type 1 pancreatic diabetes patients needed to be done 20 years earlier than on people who did not have pancreatic diabetes [33]. Being an unavoidable factor, the patient is more vulnerable to developing cataracts decades early in life.

3.2 Medications

Many studies have been done on the relationship between cataract progression and various drugs. Both children [34] and adults [35] showed a link between system corticosteroid (GCS) intake, especially at high doses and over a long period, and cataract evolvement. It's worth noting that corticosteroid-induced cataracts are usually seen in the back of the lens (back sub-capsular cataract). It was also found that patients who used GCS had a higher risk of cataracts than those who did not [28-40]. Over the last few decades, statins have been extensively used to lower cholesterol levels in blood plasma and prevent cardiovascular disease. Statins are known to have antioxidant properties, and their use may reduce the risk of cataracts. According to research [41], 5-year morbidity with cataracts was lower (12.2 %) in those who used statins than in those who didn't (17.2%); the OR was 0.55 (95% CI: 0.36 – 0.84) when age was taken into account. With corrections for sex, age, and blood lipid levels, the OR for risk of cataract evolvement in nonsmokers and people without pancreatic diabetes was 0.40 (95 percent CI: 0.18 – 0.90). It was seen that statins intake lowered the risk of senile cataracts. Although GCS cannot be avoidentirelyely, judicial use should be promoted. Statins cannot wholly prevent cataracts, but patients on statins have lesser chances of developing cataracts.

4. IONIZING RADIATIONS

The lens is among the most radiosensitive organs in the human body—the effects of ionizing radiation cause cataract evolvement [42,43]. Ionizing radiation affects the lens anterior capsule's cubical epithelial cells, which are found on the lens's surface. Damaged cells then differentiate and migrate towards the peripheral cortex and lens back pole area, resulting in the development of opacities [43]. Age, sex, dose, dose intensity, and irradiation fractioning influence the latent time and strength of effects [44,45]. Radiation-induced cataracts were assumed to be a known long-term consequence based on some long-term studies [46-47]. Several studies have linked distinct cataract forms to an increased risk of morbidity in various people exposed to ionizing radiation. Noionizingionising radiation is assumed to cause higher risks of back sub-capsular cataracts and cortical cataracts to a lesser extent. It's also worth noting that Nuclear cataracts are solely linked to age and a few other risk factors. However, the evidence for this connection is debatable. Demographically influenced radiations cannot be avoided, but occupationally related exposure to radiations can be reduced.

4.1 Irradiation Due to Atomic Bombing

Yamada et al. looked at a variety of non-tumor disorders among survivors of the atomic bombing in Japan, which doctors had monitored for a long time (1958 - 1998) [48-52]. This study demonstrated a statistically significant positive link between cataract morbidity and irradiation doses (p = 0.026). The relative risk of cataract morbidity decreased statistically significantly when a person's age at the time of the examination increased (p 0.001), as did the length of time since the irradiation moment (p = 0.09).

4.2 Irradiation Due to the Chernobyl Nuclear Powerplant Disaster

Worgul et al. performed research that revealed a statistically significant increase in non-nuclear (cortical and back subcapsular) cataracts: odds ratio per 1 Gy amounted to 1.65 (95% CI: 1.18 – 2.30), and a dose threshold for these cataracts was estimated to be equal to 0.50 (95% CI: 0.17 – 0.69) Gy. The odds ratio for all the cataract types amounted to 1.70 (95% CI: 1.22 – 2.38), and a threshold dose was equal to 1.50 (95% CI: 1.17 – 1.65) Gy [53].

4.3 Medical Irradiation

In 1999 Hall et al. examined the lens opacities frequency among Sweden population who had been exposed to ionizing irradiation in their childhood due to skin hemangioma treatment

[54]. The lens opacities frequency was shown to be higher in people who had undergone radiotherapy in their childhood against the reference group (37% and 20% correspondingly) [54]. After a correction per age at the examination moment odds ratio per 1 Gy was equal to 1.50 (95% CI: 1.15 – 1.95) for cortical cataract and to 1.49 (95% CI: 1.07 – 2.08) for basking subcapsular cataracts [55]. Although it is unavoidable, it should be used judiciously.

4.4 Cosmic Radiation

In 2001 Cucinotta et al. detected increased cataract evolvement risk in NASA astronauts [56]. The number of space flights being more than two against those who didn't have any or participated in only one flight, astronauts' age and a flight slope were statistically significant modifying factors. Hazard ratio (HR) for cataract evolvement at the age of 60 was estimated to be equal to 2.35 (95% CI: 1.01 – 5.51); and at the age of 65, 2.44 (95% CI: 1.20 – 4.98) [56-57].

4.5 Occupational Irradiation

Over the last years, some data on cataract risks for workers exposed to long-term occupational irradiation have been collected [58]. A statistically significant linear correlation between morbidity with cataracts and a total external gamma-irradiation dose was detected; excessive relative risk (ERR/Gy) was equal to 0.28 (95% CI: 0.20 – 0.37) [58]. Intervention surgeons are frequently subjected to long-term occupational irradiation. Therefore cataract risk assessment has piqued their interest recently. According to research, back sub-capsular opacities emerge at a statistically significant higher rate in intervention cardio surgeons [59,60]. Unavoidable as it is, it can be reduced [61-65].

5. CONCLUSION

To sum up the entire data, senile cataract is a multi-factor disease. Sex, age, smoking, alcohol intake, concomitant ophthalmologic pathology, some somatic disorders (for example, pancreatic diabetes), intake of certain drugs, UV radiation exposure, and so on have all been shown to be significant cataract risk factors. Researchers have discovered an elevated risk of specific cataract kinds when exposed to ionizing radiation in recent years in addition to attempting to estimate a threshold dose of external gamma radiation for the progression of specific cataract types. Avoidance of some of the avoidable factors can help reduce chances of cataracts and, from a financial point of view prevent expenditure on cataract surgery in society from a financial perspective. The article also points out some drugs which can increase or decrease the chances of cataracts, namely GCS and statins, respectively. Patients with some pre-existing pathology (pancreatic diabetes) are more prone to the development of cataracts. The article also throws light on the fact that radiations increase the chances of cataracts as seen in the population of Japan (atomic bombing) and Russia (chernobyl disaster) and in medical staff exposed to irradiations due to their occupation.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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