Original Research

Role of Vitamin C in Development of Age Related Cataract

Nahal Mostak Khan [1*], Soheb Ahmed Robin [2], Lutfullahil Khabir [3], Sohel Mahmud [4]

1. Ispahani Islamia Eye Institute and Hospital, Dhaka, Bangladesh.
2. Ispahani Islamia Eye Institute and Hospital, Dhaka, Bangladesh
3. Ispahani Islamia Eye Institute and Hospital, Dhaka, Bangladesh.
4. Ispahani Islamia Eye Institute and Hospital, Dhaka, Bangladesh.

* Correspondence: drmostaknio@gmail.com

Abstract: Cataracts or clouding of the lens is the leading cause of blindness in the world. Age and diabetes are major risk factors, and with an increasing aging and diabetic population, the burden of cataracts will grow. Since it is well established that oxidative damage plays a major role in the etiology of cataracts, antioxidants have been promoted as therapies to delay and/or prevent cataracts. Of interest is the potential for vitamin C based supplements in delaying the onset of cataracts post vitrectomy which occurs in up to 80% of patients within two years. The main goal of the study was to assess the role of vitamin C in development of cataract. The study was designed as case control study. This study was carried out at outpatient department (OPD) and in patient department of BIRDEM General Hospital, Bangladesh from July 2023 to December 2023 for a period of six (6) months. Patients presenting with cataract with age group of >50 yrs were included in study. Purposive sampling technique was used to get samples. Statistical analysis was performed by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22). Mean age was 62.9 ± 6.8 years in case and 63.8 ± 7.1 years in control. There was no significant difference in age between case and control. Males were comparatively higher in number in case than in control. Among cases, 59.3% had nuclear type, 22.2% had posterior subcapsular, 11.1% had cortical and 7.4% had mature type of cataract. In case, maximum study subjects had low serum vitamin C level. Cataract patients had significantly lower level of serum vitamin C comparing control. There was inverse correlation of serum vitamin C with age but not statistically significant (r = -0.240 and p = 0.080). It is concluded that cataract patients had low level of serum vitamin C comparing controls. Further large scale study should be conducted. Multi centered study should be done.

Keywords: Vitamin C, Cataract, Age changes, development, gender, Vitrectomy

1. INTRODUCTION

In the modern world, cataracts are the primary and most common cause of treatable blindness. A cataract is any degree of lens opacity, from a single dot to total opacification. It arises when the typically clear and transparent lens in the eye becomes hazy. Etiologically, it is divided into congenital and acquired types [1]. The free oxygen radicals produced during the lens's regular, everyday metabolic

processes put the ocular lens at greater risk of photo-oxidative damage when it is continuously exposed to ultraviolet radiation and ambient oxygen. Thus, free radicals contribute significantly to the oxidation of lens proteins, which causes lens opacification and cataract development. To reduce this photooxidative damage to the ocular lens, the body's defence mechanisms with antioxidants like ascorbic acid (vitamin C), glutathione S-Transferase (GST), and vitamins that eliminate, scavenge, and suppress the formation of free radicals or oppose the actions of the free radicals play a crucial role [2]. Despite the fact that cataracts can be surgically removed and replaced with an artificial intraocular lens to restore vision, many cataract sufferers do not receive the necessary medical care or the cost of the procedure is too high [3]. Therefore, determining the cataract's modifiable risk factors is crucial and could aid in developing preventative strategies. Chronic oxidative stress causes an increase in ocular lens protein modification due to inadequate antioxidant micronutrient uptake by the lens. This protein works as an efficient physiological antioxidant at lower partial pressures of oxygen to defend against oxidative stress-related illnesses [4]. Ascorbic acid, another name for vitamin C, is a water-soluble vitamin that is easily obtained in a variety of foods but cannot be synthesised by humans. The most well-known sources of vitamin C are citrus fruits and vegetables [6]. For men, the Recommended Dietary Allowance (RDA) for vitamin C is 90 milligrammes per day, whereas for women it is 75 mg per day [7]. The standard range for vitamin C levels in plasma is 0.6-2 mg/dl; levels below this range are deemed inadequate [8]. The kidneys eliminate vitamin C after it has been metabolised in the liver. Vitamin C excretion threshold in the kidneys is 1.4 mg/100 ml. Unaltered, excess vitamin C is eliminated in the urine. Vitamin C excretion is reduced when plasma concentrations of the vitamin are low. It is advised in cases of numerous eye problems, such as senile cataract, macular degeneration, glaucoma, and vitreous detachment, due to its potent anti-free-radical properties [9]. Additionally, it lessens the opacity of the cornea brought on by infectious keratitis [10]. A study was undertaken by Al-Talqani et al. [11] at the Ibn-Alhaitham Teaching Eye Hospital in Baghdad to investigate the relationship between age-related cataract and low serum vitamin C levels. This investigation involved one hundred participants. Fifty cataract patients who were seen in the outpatient department were compared to fifty healthy volunteers who were age matched. ELISA was used to measure the level of vitamin C in serum. In patients with cataracts, the mean serum vitamin C level was 0.47 ± 0.38 mg/dl, while in controls it was 0.81 ± 0.52 mg/dl. The test group's vitamin C level was much lower than that of the control group ($p = 0.001$). Nuclear and mature cataracts were substantially correlated with low serum vitamin C levels. According to this study, elderly cataract patients had lower serum vitamin C levels than healthy people. Wei et al. [12] investigated if vitamin C is a preventive factor against age-related cataracts by epidemiological research and meta-analysis. Additionally, inverse relationships between serum ascorbate and posterior sub-capsular and nuclear cataracts were discovered. The risk of cataract may be inversely correlated with higher vitamin C intake and serum ascorbate levels. It is recommended to consume vitamin C in order to prevent cataracts in the first place. In order to determine if vitamin C prevents or delays the progression of age-related cataracts, Liu et al. [13] performed a meta-analysis. Pooled data were measured using risk ratios (RRs) and odds ratios (ORs) with matching 95% confidence intervals (CIs). This meta-analysis comprised a total of 25 research, consisting of 11 cohort studies, 6 case-control studies, and 8 cross-sectional studies. Nuclear cataracts are protected against by vitamin C, according to subgroup analysis based on cataract types (RR: 0.51, 95% CI: 0.32 to 0.81). Case-control studies revealed a comparable protective effect (OR:0.61, 95% CI: 0.47 to 0.79). Increased serum ascorbate levels and vitamin C intake may help prevent age-related cataracts, particularly nuclear cataracts. It is suggested that elderly adults attempt to boost their consumption of vitamin C in order to prevent cataracts. The opacity of the human crystalline lens causes

cataract development. Because it has antioxidant properties, vitamin C keeps lenses from becoming opacified. When vitamin C levels fall below normal, their antioxidant properties on lenses also decline. Thus, a lower vitamin C level was associated with a higher risk of cataract formation. The purpose of this study was to measure the blood levels of vitamin C in cataract patients and compare the findings with vitamin C levels in healthy, age-matched subjects. Evaluating the effect of vitamin C in cataract development is the study's ultimate objective. The results of this study will assist us in determining whether vitamin C deficiency and the development of cataracts are related in any way.

2. MATERIALS AND METHODS

This study was designed as case control study. This study was carried out at outpatient department (OPD) and in patient department of BIRDEM General Hospital, Bangladesh from July 2023 to December 2023 for a period of six (6) months. Patients with cataract and without cataract admitted or attending OPD of Ophthalmology of BIRDEM General Hospital, Dhaka during study period were part of this study. Prior to the commencement of this study, the research protocol was approved by the ethical committee (Local Ethical committee) of BCPS. The aims and objectives of the study along with its procedure, methods, risks and benefits of this study were explained to the respondent in easily understandable local language and then informed consent was taken from each patient. It was assured that all informed and records would be kept confidential and the procedure was helpful for both the physicians and the patients in making rational approach of the case management. Patients presenting with cataract with age group of >50 years were included in study. Patients with other ocular diseases like glaucoma and uveitis, patients who have history of ocular trauma, patients with history of taking steroids for long time, and patients those who are on multivitamin supplement. Purposive sampling technique was used to get samples. Sample size was calculated using the following formula:

$$n = \frac{(Z_\alpha + Z_\beta)^2 \times (\sigma_1^{\,2} + \sigma_2^{\,2})}{(\mu_1 - \mu_2)^2}$$

Here, n= sample size

μ1 = 0.54 [Mean serum vitamin C level in cases (Angirekula et al., 2018).
μ2 = 0.83 [Mean serum vitamin C level in controls (Angirekula et al., 2018).
σ1 = 0.23 [SD of serum vitamin C in cases (Angirekula et al., 2018).
σ2 = 0.35 [SD of serum vitamin C in controls (Angirekula et al., 2018).
Z_α = 1.96 at a 95% confidence interval Z_β = 1.64 at a 95% power

Putting the values in the above equation the sample size n is estimates as

$$n = \frac{(1.96 + 1.64)^2 \times (0.23^2 + 0.35^2)}{(0.54 - 0.83)^2} = 27$$

Final samples were 27 in each group.

Vitamin C levels in plasma and plasma Vitamin C in subtypes of cataract were the variables of study. Twenty seven patients attending the Out Patient Department (OPD) and admitted in patient Department of Department of Ophthalmology, BIRDEM General Hospital, and Dhaka with cataract were enrolled in this study as per inclusion and exclusion criteria. Twenty seven age and sex matched control were

enrolled from attendant of the patients. After taking written consent, a questionnaire included socio-demographic data, clinical findings; laboratory findings were filled up for each patient. Plasma vitamin C level was examined for each patients and controls. A volume of 300 μl plasma and 1.2 ml TCA solution was taken in a test tube, mixed well and centrifuged at 3000 rpm for 10 min. Clear supernatant of 0.96 ml was treated with 0.4 ml DTC solution and heated at 60^0C for 60 min in a water bath. Immediately after incubation, the sample was chilled in ice-cold water and 1.6 ml of 65% sulphuric acid solution was added gradually. The procedure was repeated with 0.3 ml of working standard solution of ascorbic acid as well as with 0.3ml of reagent blank. Absorbances of sample and standard were read against regent blank at 520 nm in the spectrophotometer (UV- 1800, Shimadzu Corporation, Japan). All data were compiled and edited meticulously. The data were screened and were checked for any missing values and discrepancy. All omissions and inconsistencies were corrected and were removed methodically. Computer based statistical analysis were carried out with appropriate techniques and systems with the help of professional statistician. All data were recorded systematically in preformed data collection form (questionnaire) and quantitative data were expressed as mean and standard deviation and qualitative data were expressed as frequency distribution and percentage. Statistical analysis was performed by using window based computer software devised with Statistical Packages for Social Sciences (SPSS-22). 95% confidence limit was taken. The summarized data was interpreted accordingly and was then presented in the form of tables.

3. RESULTS AND DISCUSSION

Group I consisted of patients with cataracts, and Group II was the control group, which included people without cataracts. Table 1 displays the age distribution of the research participants in the case and control groups; Figure 2 displays the gender distribution; and Figure 3 displays the study subjects' place of residence. In both groups, the maximum patient age range was 61 to 70 years old. In case, the mean age was 62.9 ± 6.8 years, while in control, it was 63.8 ± 7.1 years. There was no discernible age difference between the case and control groups. The age distribution of cases and controls is depicted in Figure 1. Within the age range of 61-70 years, 51.9% of cases and 48.1% of controls were present. The gender distribution of the study participants in the case and control groups is displayed in Table 2. Comparatively speaking, there were more men in the case than in the control. There was no discernible gender difference between the case and control groups. The distribution of study participants by place of residence for the case and control is displayed in Table 3. Maximum number of urban study participants in both groups (63.0% vs. 66.7%). Between the case and control groups, there was no discernible difference in residence. The study individuals' cataract types are displayed in Table 4. Of the cases, 22.2% had posterior subcapsular cataracts, 11.1% had cortical cataracts, 7.4% had mature cataracts, and 59.3% had nuclear cataracts. The serum vitamin C levels of the case and control study participants are displayed in Table 5. When compared to controls, the serum vitamin C level in cataract patients was considerably lower. In cases, the mean serum vitamin C level was 0.49 ± 0.35 mg/dl, while in controls, it was 0.81 ± 0.54 mg/dl. Figure 4 showed that, although not statistically significant, there is an inverse relationship between serum vitamin C and age ($r = -0.240$ and $p = 0.080$).

Table 01: Distribution of the study subjects according to age in case and control (N=54)

Age (years)	Group I (Case) (n=27)	Group II (Control) (n=27)	p-value
51 – 60	10 (37.0)	9 (33.3)	
61 – 70	14 (51.9)	13 (48.1)	
71 – 80	3 (11.1)	5 (18.5)	
Mean ± SD	62.9 ± 6.8	63.8 ± 7.1	0.653^{ns}
Min – max	51 – 75	51 – 77	

*s – Significant, *ns – Non significant, *p value reached from unpaired t test

Table 02: Age distribution of in case and control (N=54)

Gender	Group I (Case) (n=27)	Group II (Control) (n=27)	p-value
Male	16 (59.3)	14 (51.9)	0.584^{ns}
Female	11 (40.7)	13 (48.1)	

*s – Significant, *ns – Non significant, *p value reached from Chi-Square test

Table 03: Study subjects distribution according to residence in case and control (N=54)

Residence	Group I (Case) (n=27)	Group II (Control) (n=27)	p-value
Urban	17 (63.0)	18 (66.7)	0.776^{ns}
Rural	10 (37.0)	9 (33.3)	

Table 04: Type of cataract of the study subjects (N=27)

Type of cataract	Frequency	Percentage
Nuclear	16	59.3
Posterior sub-capsular	6	22.2
Cortical	3	11.1
Mature	2	7.4

Table 05: Distribution of the study subjects according to age in case and control (N=54)

Serum vitamin C (mg/dl)	Group I (Case) (n=27)	Group II (Control) (n=27)	p-value
Low (≤0.6)	18 (66.7)	9 (33.3)	0.014^{s}
Normal (>0.6)	9 (33.3)	18 (66.7)	

Mean ± SD	0.49 ± 0.35	0.81 ± 0.54	0.013[s]
Min – max	0.12 – 1.67	0.17 – 1.91	

*s – Significant, *ns – Non significant, *p value reached from Chi-Square test

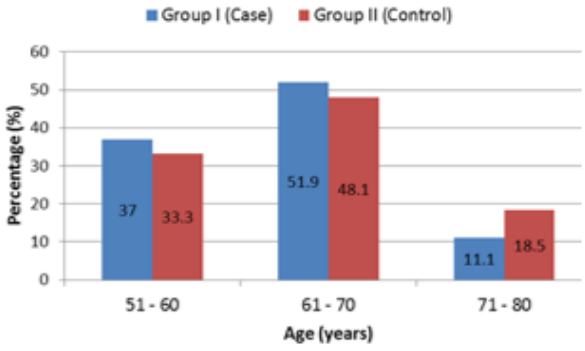

Figure 01: Age distribution in cases and controls

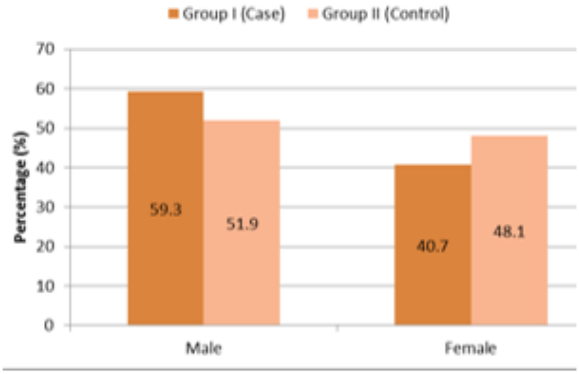

Figure 02: Gender distribution

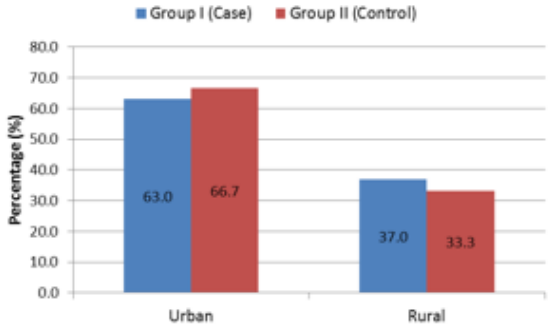

Figure 03: study subjects according to residence in case and control

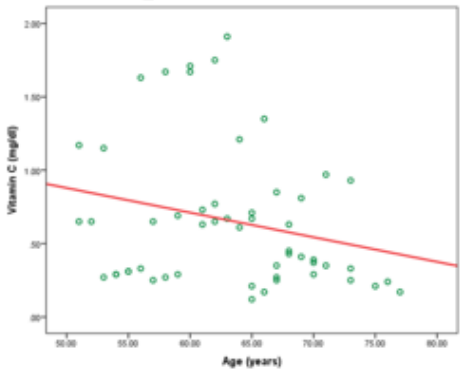

Figure 04: Correlation of Vitamin C with age

Senile cataracts are known to be caused by a number of risk factors, the most significant of which are preventable: exposure to ultraviolet (UV) radiation, particularly UV-B radiation, and nutritional deficiencies [14]. Currently, the only treatment options are IOL implants and surgically removing the cataract's lens. But the frequency is so high that the surgical facilities that are now available cannot handle the issue. Postoperative problems include uncorrected residual refractive error, endophthalmitis, and posterior capsular opacification might also arise. Consequently, efforts are being made to find a pharmaceutical intervention that will keep the lens transparent [15]. In the past few decades, a great deal of study has been done to identify the cause of cataracts. Many substances, particularly antioxidants like vitamin C, have been used in an attempt to postpone the development of cataracts and slow down their progression. However, there is ample evidence that vitamins, particularly vitamin C, can prevent cataracts. Vitamin C functions as a UV filter in addition to being an antioxidant in lens biology [16]. We attempted to evaluate the connection between age-related cataract and vitamin C in this study. The age range of the study's maximum patients in both groups was 61 to 70 years old. In case, the mean age was 62.9 ± 6.8 years, while in control, it was 63.8 ± 7.1 years. There was no discernible age difference between the case and control groups. A similar result was noted in the study conducted by Al-Talqani et al. [17]. In that study, the majority of patients were in the 61–70 year age range, and the mean age of the

case and control groups was 64.6 ± 7.9 years and 63.2 ± 6.8 years, respectively. There was no discernible age difference between the case and control groups. Although there were much more men in the case than the control, there was no discernible gender difference. The ratio of men to women was 1.45:1 for the case and 1.07:1 for the control. The male to female ratios in the case and control groups of Al-Talqani et al.'s study [17] were 1.5:1 and 1.63:1, respectively. In this study, the majority of research participants in both groups (64.0 vs. 66.7%) were from urban areas. Between the case and control groups, there was no discernible difference in residence. The majority of study participants in the Al-Talqani et al. (2019) study came from metropolitan areas, both in the case and control groups (64.0% vs. 70.0%). Of the cases, 22.2% had posterior subcapsular cataracts, 11.1% had cortical cataracts, 7.4% had mature cataracts, and 59.3% had nuclear cataracts. According to the study [17], nuclear cataract accounts for 60% of all cataract cases; posterior subcapsular (22%), cortical (10%), and mature cataract (8%), in that order, are the most common forms among cataract patients. In this study, vitamin C levels were low in 33.3% of controls and 66.7% of cataract patients. When compared to controls, the serum vitamin C level in cataract patients was considerably lower. The cataract patients' mean serum vitamin C level was 0.49 ± 0.35 mg/dl, while the control group's mean was 0.81 ± 0.54 mg/dl. In the study [17], low vitamin C levels were found in 36 (72.0%) cataract patients and 22 (44.0%) controls, while normal vitamin C levels were found in 14 (33.3%) cataract patients and 28 (66.7%) controls. These data showed that the likelihood of low vitamin C levels was more than three times higher in cataract patients than in the normal population (controls) (odds ratio 3.27, p = 0.005). The cataract patients' mean serum vitamin C level was 0.47 ± 0.38 mg/dl, while the control group's mean was 0.81 ± 0.52 mg/dl. The mean serum vitamin C level in patients with cataracts was 0.54 ± 0.23 mg/dl in the research [18], while it was 0.83 ± 0.35 mg/dl in controls. The findings of a study [18] are highly consistent with our findings, showing that vitamin C concentrations in patients with age-related cataracts were considerably lower than those in the control group (p = <0.001). Low serum vitamin C levels have been linked to senile cataract patients in a number of epidemiological investigations [19–21]. The present research has certain shortcomings. As per the study's design, it was a single-center investigation. Conducting the study in a multicentric approach that encompasses both urban and rural locations may yield superior results. A lower range was used to calculate the sample size. But additional information would come from a bigger sample size.

4. CONCLUSIONS

The most common cause of blindness worldwide is cataracts, or clouding of the lens. Two of the main risk factors are age and diabetes, and as the population ages and becomes more diabetic, the incidence of cataracts will rise. Antioxidants have been pushed as treatments to postpone and/or prevent cataracts because it is widely known that oxidative damage is a major factor in the aetiology of cataracts. The possibility that vitamin C-based supplements could postpone the development of cataracts after vitrectomy—which affects up to 80% of patients within two years—is intriguing. The primary objective of the research was to evaluate the function of vitamin C in the onset of cataracts. It was concluded that there was no discernible age difference between the case and control groups. Comparatively, there were more men in the case than in the control. If the majority of research participants had low serum vitamin C levels after comparison of the controls, the serum vitamin C level in cataract patients was considerably lower. Age and serum vitamin C had an unfavourable relationship, however it was not statistically significant (r = -0.240 and p = 0.080). Comparing cataract patients to controls, it is determined that they had lower serum vitamin C levels. Larger-scale research should be done in the future. A multicenter investigation ought to be conducted.

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