Role of Vitamin C in Development of Age Related Cataract

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Abstract: 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. The research was intended to be a case-control study. This study was conducted over the course of six (6) months, in the patient and outpatient departments of BIRDEM General Hospital in Bangladesh, from July 2023 to December 2023. The study comprised patients with cataract presentations who were older than 50 years of age. To get samples, a purposeful sampling strategy was applied. Statistical Packages for Social Sciences (SPSS-22) was used to create window-based computer software for statistical analysis. 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 lenses 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 milligrams 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

The design of this study was case control. This study was conducted over the course of six (6) months, in the patient and outpatient departments of BIRDEM General Hospital in Bangladesh, from July 2023 to December 2023. This study included both cataract-free and cataract-affected patients who were admitted to or saw the outpatient department (OPD) of the ophthalmology department at BIRDEM General Hospital, Dhaka, during the study period. The research protocol was authorised by the BCPS ethical committee (local ethical committee) before the study started. After providing the respondent with a readily understood explanation of the study’s goals, procedures, risks, and benefits in their native tongue, each patient gave their informed permission. Patients and doctors alike found the process to be beneficial in helping them approach case management logically, and it was guaranteed that all information and records would be kept private. The study comprised patients with cataract presentations who were older than 50 years of age. Individuals with a history of ocular damage, long-term steroid use, other ocular illnesses such as glaucoma and uveitis, and multivitamin supplement users are among the eligible individuals. Purposive sampling technique was used to get samples. Sample size was calculated using the following formula:

\[
n = \frac{(Z_a + Z_β)^2 \times (σ_1^2 + σ_2^2)}{(μ_1 - μ_2)^2}
\]

Here, \(n\) = sample size

\(μ_1 = 0.54\) [Mean serum vitamin C level in cases (Angirekula et al., 2018).
\(μ_2 = 0.83\) [Mean serum vitamin C level in controls (Angirekula et al., 2018).
\(σ_1 = 0.23\) [SD of serum vitamin C in cases (Angirekula et al., 2018).
\(σ_2 = 0.35\) [SD of serum vitamin C in controls (Angirekula et al., 2018).
\(Z_a = 1.96\) 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.

Levels of vitamin C in plasma and the variables under investigation were subtypes of cataract and vitamin C. According to the inclusion and exclusion criteria, 27 patients with cataracts who were admitted to the patient department of the Department of Ophthalmology at BIRDEM General Hospital in Dhaka and attended the Out Patient Department (OPD) were included in this study. Twenty-seven controls who were matched for sex and age were recruited from the patients' attendants. Following the acquisition of signed consent, each patient’s laboratory results and sociodemographic information were entered into a questionnaire along with clinical findings. The level of vitamin C in plasma was measured for both patients and controls. In a test tube, a volume of 300 μl plasma and 1.2 ml TCA solution were combined, thoroughly mixed, and centrifuged for 10 minutes at 3000 rpm. 0.96 ml of clear supernatant was heated
in a water bath for 60 minutes at 600°C after being treated with 0.4 ml of DTC solution. Following incubation, the sample was quickly refrigerated in ice-cold water, and 1.6 ml of a solution containing 65% sulfuric acid was progressively added. The process was carried out again using 0.3 ml of ascorbic acid working standard solution and 0.3 ml of reagent blank. Sample and standard absorbances were measured in the UV-1800 spectrophotometer (Shimazu Corporation, Japan) at 520 nm against a reference blank. Every piece of data was carefully edited and assembled. The information was filtered and examined for inconsistencies and missing values. Every error and discrepancy was fixed and eliminated meticulously. With the assistance of a qualified statistician, proper procedures and systems were used to conduct computer-based statistical analysis. Quantitative data were expressed as mean and standard deviation, while qualitative data were expressed as frequency distribution and percentage. All data were methodically documented in a pre-made data collecting form (questionnaire). Statistical Packages for Social Sciences (SPSS-22) was used to create window-based computer software for statistical analysis. A 95% confidence interval was used. Following an appropriate interpretation, the condensed data was presented as tables.

3. RESULTS AND DISCUSSION

Patients with cataracts made up Group I, whereas those without the condition made up the control group. The age distribution of the research participants in the case and control groups is shown in Table 1, the gender distribution is shown in Figure 2, and the residency of the study subjects is shown in Figure 3. The maximum patient age range in both groups was between 61 and 70 years old. The mean age in the case was 62.9 ± 6.8 years, whereas it was 63.8 ± 7.1 years in the control group. The age differences between the case and control groups were negligible. Figure 1 shows the age distribution of the patients and controls. There were 51.9% of cases and 48.1% of controls in the 61–70 age group. Table 2 shows the gender distribution of study participants in the case and control groups. In comparison, there were more males in the control group than in the case. The case and control groups did not exhibit any appreciable gender differences. Table 3 shows the study participants’ residence distribution for the case and control groups. Maximum number of participants in both groups (63.0% vs. 66.7%) for the urban research. The residency of the case and control groups did not significantly differ from one another. Table 4 shows the cataract kinds of the study participants. Of the patients, nuclear cataracts accounted for 59.3%, cortical cataracts for 11.1%, mature cataracts for 7.4%, and posterior subcapsular cataracts for 22.2% of the cases. Table 5 shows the serum vitamin C levels of the subjects in the case and control studies. Cataract patients have significantly lower serum vitamin C levels than controls. The mean serum vitamin C level in the cases was 0.49 ± 0.35 mg/dl, whereas it was 0.81 ± 0.54 mg/dl in the controls. Figure 4 demonstrated that there is an inverse association between serum vitamin C and age (r = -0.240 and p = 0.080), but one that is not statistically significant.

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

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Group I (Case) (n=27)</th>
<th>Group II (Control) (n=27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>51 – 60</td>
<td>10 (37.0)</td>
<td>9 (33.3)</td>
<td></td>
</tr>
<tr>
<td>61 – 70</td>
<td>14 (51.9)</td>
<td>13 (48.1)</td>
<td></td>
</tr>
<tr>
<td>71 – 80</td>
<td>3 (11.1)</td>
<td>5 (18.5)</td>
<td></td>
</tr>
</tbody>
</table>
### Table 02: Age distribution of in case and control (N=54)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Group I (Case) (n=27)</th>
<th>Group II (Control) (n=27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>16 (59.3)</td>
<td>14 (51.9)</td>
<td>0.584ns</td>
</tr>
<tr>
<td>Female</td>
<td>11 (40.7)</td>
<td>13 (48.1)</td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Residence</th>
<th>Group I (Case) (n=27)</th>
<th>Group II (Control) (n=27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>17 (63.0)</td>
<td>18 (66.7)</td>
<td>0.776ns</td>
</tr>
<tr>
<td>Rural</td>
<td>10 (37.0)</td>
<td>9 (33.3)</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type of cataract</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nuclear</td>
<td>16</td>
<td>59.3</td>
</tr>
<tr>
<td>Posterior sub-capsular</td>
<td>6</td>
<td>22.2</td>
</tr>
<tr>
<td>Cortical</td>
<td>3</td>
<td>11.1</td>
</tr>
<tr>
<td>Mature</td>
<td>2</td>
<td>7.4</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Serum vitamin C (mg/dl)</th>
<th>Group I (Case) (n=27)</th>
<th>Group II (Control) (n=27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (≤0.6)</td>
<td>18 (66.7)</td>
<td>9 (33.3)</td>
<td>0.014*</td>
</tr>
<tr>
<td>Normal (&gt;0.6)</td>
<td>9 (33.3)</td>
<td>18 (66.7)</td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>0.49 ± 0.35</td>
<td>0.81 ± 0.54</td>
<td>0.013*</td>
</tr>
<tr>
<td>Min – max</td>
<td>0.12 – 1.67</td>
<td>0.17 – 1.91</td>
<td></td>
</tr>
</tbody>
</table>

*s – Significant, *ns – Non significant, *p value reached from Chi-Square test
Many risk factors have been linked to senile cataracts, the most important of which are avoidable: exposure to ultraviolet (UV) radiation, especially UV-B radiation, and malnutrition [14]. As of right now, the only available treatments are surgical cataract lens extraction and IOL implants. However, the frequency is so great that the current state of surgical facilities is unable to address the problem. Uncorrected residual refractive error, endophthalmitis, and posterior capsular opacification are possible postoperative complications. As a result, research is underway to identify a medication that will maintain the lens’ transparency [15]. The cause of cataracts has been extensively studied during the last few decades. Many drugs, especially antioxidants like vitamin C, have been tried to delay the onset of cataracts and slow down their advancement. Nonetheless, there is a wealth of data supporting the prevention of cataracts by vitamins, especially vitamin C. In lens biology, vitamin C serves as both an antioxidant and a UV filter [16].

In this work, we tried to assess the relationship between age-related cataract and vitamin C. The study’s maximal patient age range for both groups was between 61 and 70 years old. The mean age in the case was 62.9 ± 6.8 years, whereas it was 63.8 ± 7.1 years in the control group. The age differences between the case and control groups were negligible. An like outcome was observed in the research carried out by Al-Taloani et al. [17]. The bulk of the patients in that study ranged in age from 61 to 70 years, with mean ages of 64.6 ± 7.9 years for the case group and 63.2 ± 6.8 years for the control group, respectively. The age differences between the case and control groups were negligible. There was no appreciable gender difference, despite the fact that the case had significantly more men than the control. In the example, the
male to female ratio was 1.45:1, while in the control group it was 1.07:1. In the case and control groups of Al-Talqani et al.’s study [17], the male to female ratios were 1.5:1 and 1.63:1, respectively. The majority of research participants (64.0% vs. 66.7%) in both groups in this study were city dwellers. The residency of the case and control groups did not significantly differ from one another. In the Al-Talqani et al. (2019) study, the case and control groups had similar proportions of participants from urban areas (64.0% vs. 70.0%). Of the patients, nuclear cataracts accounted for 59.3%, cortical cataracts for 11.1%, mature cataracts for 7.4%, and posterior subcapsular cataracts for 22.2% of the cases. The study [17] states that nuclear cataract makes about 60% of all cases of cataracts; the most common kinds among cataract patients are posterior subcapsular (22%), cortical (10%), and mature cataract (8%), in that order. In this study, 66.7% of cataract patients and 33.3% of controls had inadequate vitamin C levels. Cataract patients have significantly lower serum vitamin C levels than controls. The mean serum vitamin C level in cataract patients was 0.49 ± 0.35 mg/dl, whereas the control group had a mean of 0.81 ± 0.54 mg/dl. According to the study [17], 14 (33.3%) cataract patients and 28 (66.7%) controls had normal vitamin C levels, while 36 (72.0%) cataract patients and 22 (44.0%) controls had low vitamin C levels. According to these findings, individuals with cataracts had a greater probability of having low vitamin C levels than people in the general population (controls) (odds ratio 3.27, $p = 0.005$). The mean serum vitamin C level in cataract patients was 0.47 ± 0.38 mg/dl, whereas the control group had a mean of 0.81 ± 0.52 mg/dl. The study found that the mean serum vitamin C level in individuals with cataracts was 0.54 ± 0.23 mg/dl [18], whereas the mean level in controls was 0.83 ± 0.35 mg/dl. The results of a study [18] that showed that vitamin C concentrations in patients with age-related cataracts were significantly lower than those in the control group ($p = <0.001$) are quite similar to our findings. Numerous epidemiological studies have connected senile cataract patients with low serum vitamin C levels [19–21]. There are some issues with the current study. The study was a single-center investigation in accordance with its design. A lesser range was employed to calculate the sample size; a multicentric method that includes both urban and rural sites may produce better findings. However, more data would come from a larger 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.

REFERENCES


