

Vitamin C Concentration of Aqueous Humour and Plasma in Patients with Senile Cataract

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Aim: Senile cataract is one of the most important preventive causes of blindness in the world. Oxidative agents such as ultraviolet light are one of the important causes of cataract. Vitamin C is an important water-soluble antioxidant agent in the aqueous humour.

Patients and Methods: In a descriptive, cross-sectional study, 85 patients who were admitted to Rah-Ahan Eye Hospital, Iran, for cataract surgery were evaluated. With patients under general anaesthesia, 0.2 mL of aqueous from the anterior chamber and 5 mL of peripheral blood were taken prior to the operation. The concentration of vitamin C in these samples was measured.

Results: The mean age of the patients was 64.3 ± 1.2 years. Forty one patients were men and 44 were women. The mean concentration of vitamin C was 4.29 ± 0.12 mg/dL (mean \pm standard error) in the aqueous and 0.77 ± 0.04 mg/dL in the plasma. Vitamin C concentrations in aqueous were similar in both sexes, but vitamin C concentrations in plasma of women were higher than those in plasma of men ($p = 0.043$). The concentration of vitamin C was not related to the type of cataract or patients' employment.

Conclusions: Because vitamin C concentrations of aqueous and plasma in senile cataract are lower than normal, it is recommended that patients who are at risk for senile cataract consume fresh vegetables and fruits or other forms of vitamin supplements.

Key Words: Aqueous, Cataract, Plasma, Vitamin C

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Introduction

Cataract is one of the most important preventive causes of blindness in the world and is the cause of blindness for 15 million people worldwide.

Senile cataract is the most prevalent form of cataract and has the greatest social and economic importance.¹ Many risk factors are known to cause senile cataract and one of the most important is ultraviolet (UV) light, especially UVB.²⁻⁶ UV acts as an oxidant

agent. Light and oxygen are necessary for eye function, but excessive and uncontrollable exposure of the eye to these elements can cause cataract. The value of antioxidants decreases with age.⁶ Vitamin C is one of the most important antioxidant agents.⁷

The lens contains crystallin and proteins with special structures that are important for the maintenance of lens transparency. A senile change of crystallin in the lens as a result of oxidation is a cause of cataract.⁸ It has been proven in animal studies that a diet low in vitamin C and exposure to UVB result in oxidative stress and can cause cataract after some weeks.⁴ However, it is not possible to reproduce this study in humans.

Research in the literature shows that the risk for cataract is lowered for people who consume 60 mg or more vitamin C daily (in food or supplements).⁹ The benefit of this diet has been confirmed through epidemiologic studies and clinical experiments, in which the antioxidant effect of vitamin C has been shown to decrease oxidative damage.¹⁰ As there is much sunshine in Iran, the prevalence of cataract is relatively high.

There has been no research into the vitamin C concentration of aqueous in patients who are at risk for cataract in Yazd, Iran. However, a study has shown that the vitamin C concentration of operated lenses is associated with lens turbidity.¹¹ This study was performed to investigate the vitamin C concentration of aqueous in patients with cataract and whether this is related to the vitamin C concentration of plasma.

Patients and Methods

This descriptive, cross-sectional study was done at the Rah-Ahan Eye Hospital, Shahid Sadoughi University of Medical Sciences, Yazd, Iran. The study specimens were collected from patients with senile cataract

who were admitted to the ophthalmology ward for cataract surgery at the time of the study. The patients were aged between 40 and 85 years and did not have any concomitant morbidity. The number of patients required was estimated to be 85, based on previous data and 95% confidence intervals (CIs). The data were obtained from interviews with the patients, observation by the surgeons, and the laboratory results.

After general anaesthesia was given and just prior to the beginning of cataract surgery, 0.2 mL of aqueous was taken from the anterior chamber through the limbus. Surgery was continued by capsulotomy performed with a needle connected to Ringer's solution. At the same time, 5 mL of peripheral blood was collected and sent to the laboratory to measure the vitamin C concentration. The variables of this study were age, sex, type of cataract, and vitamin C concentration of aqueous and plasma in patients who were undergoing cataract surgery.

Vitamin C concentration was measured by spectrophotometry and colorimetry. Briefly, wavelengths of light after passing through each specimen were examined, and vitamin C was measured in volume units using special curves.

Results

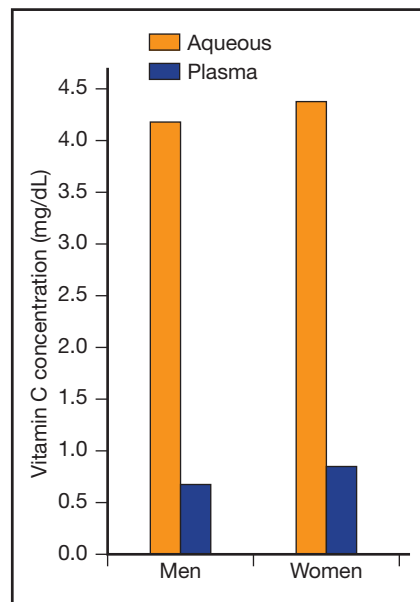
Eighty five patients (41 men and 44 women) undergoing cataract surgery were enrolled in the study. The patients' ages were between 40.0 and 85.0 years (mean \pm standard error, 64.3 ± 1.2 years).

The mean vitamin C concentration of aqueous was 4.29 ± 0.12 mg/dL (range, 0.76 to 6.06 mg/dL; 95% CI, 4.05-4.54 mg/dL). Vitamin C concentrations of aqueous according to the patients' ages are shown in Table 1. It appears that the vitamin C concentration of aqueous decreased as age increased, but this reduction was not statistically significant. Figure 1 shows

Table 1. Vitamin C concentration of aqueous and plasma in patients with cataract according to age.

Age (years)	Number of patients	Aqueous vitamin C concentration (mg/dL)		Plasma vitamin C concentration (mg/dL)	
		Mean	Standard deviation	Mean	Standard deviation
40-59	27	4.62	1.00	0.72	0.22
60-69	27	4.20	1.10	0.83	0.39
70-85	31	4.08	1.20	0.76	0.36

Figure 1. Vitamin C concentration of aqueous and plasma according to sex.



the vitamin C concentration of aqueous according to sex. Although these values were slightly higher in women than in men, the difference was not statistically significant. Table 2 shows the vitamin C concentration of aqueous according to the patients' employment — the differences were not statistically significant. Figure 2 shows the vitamin C concentrations of aqueous in different types of cataracts. Although the vitamin C concentrations of aqueous showed different values according to the type of

Table 2. Vitamin C concentration of aqueous and plasma in patients with cataract according to employment.

Employment	Number of patients	Vitamin C concentration of aqueous (mg/dL)		Vitamin C concentration of plasma (mg/dL)	
		Mean	Standard deviation	Mean	Standard deviation
Housewife	43	4.40	0.96	0.84	0.36
Industrial and agricultural worker	18	4.22	1.12	0.68	0.30
Other professional	24	4.20	1.38	0.73	0.24

cataract, these differences were not statistically significant.

The mean vitamin C concentration of plasma was 0.77 ± 0.04 mg/dL (range, 0.26 to 2.20 mg/dL; 95% CI, 0.70-0.84 mg/dL). As shown in Table 1, these values were not related to age. However, as shown in Figure 1, they were significantly higher in women than in men ($p = 0.043$). Vitamin C levels in the plasma were not related to the patients' professions (Table 2) or to type of cataract (Figure 2) — the differences were not statistically significant.

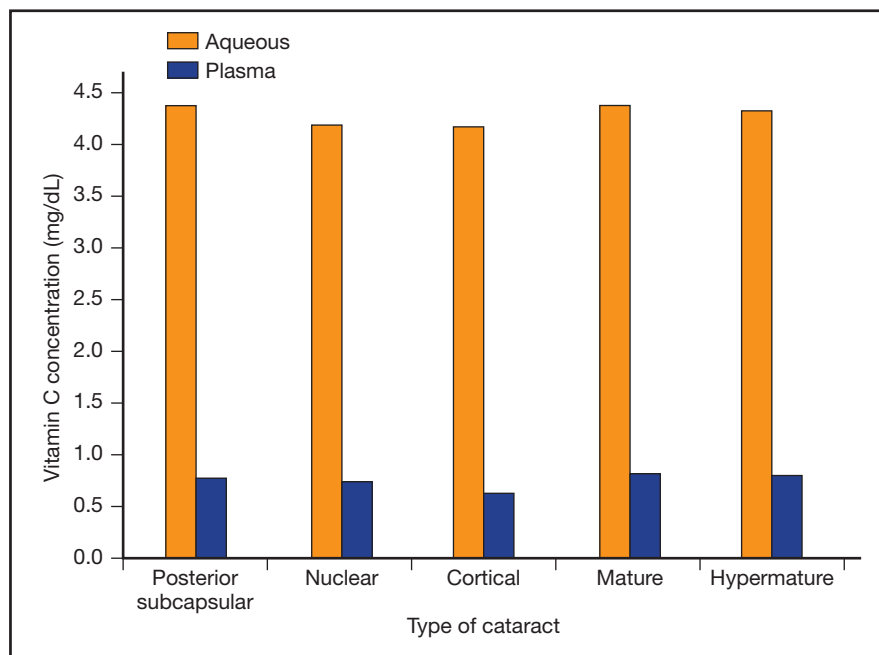
The relationship between vitamin C concentration of aqueous and vitamin C concentration of plasma was analysed by Pearson's correlation test, which found a non-significant difference. However, there was a positive relationship between the mean vitamin C concentration of plasma and aqueous.

Discussion

Recently, approaches other than surgery, including medical and non-medical approaches, to delay cataract progression have been considered. If formation of cataract could be delayed for 10 years, the number of patients who need surgery will



Figure 2. Vitamin C concentration of aqueous and plasma in patients with different types of cataract.



be reduced by 45%.¹² Antioxidant foods such as those that are rich in vitamin C have protective effects against some chronic diseases such as cancer, cardiac diseases, and cataract.^{4,9-11,13-16} Vitamin C is one of the most important antioxidants found in aqueous. The normal vitamin C concentration in serum is 0.6 to 2.0 mg/dL.¹⁷ The maximum concentration of vitamin C in aqueous is 60 to 85 mg/dL, which is 20 to 30 times that in plasma.¹⁷⁻¹⁹ According to the results of this study, the mean concentration of vitamin C in aqueous was 4.29 ± 0.12 mg/dL and the mean concentration in plasma was 0.77 ± 0.04 mg/dL. The vitamin C concentrations, especially for aqueous, were statistically significantly different.

In the study of Bates et al, 1 eye of each of 7 patients who had bilateral cataract was operated on and the operated lenses was analysed.²⁰ After operation, 3 patients were given vitamin C and 4 given placebo for 3 months and the cataract of the other eye was operated. Consequently, the vitamin C concentration of the aqueous and lens of patients taking vitamin C had increased.

In the study of Taylor et al, plasma of 77 patients with cataract and 35 controls were examined. These researchers concluded that the vitamin C concentration in patients with cataract was lower than that in the control group ($p < 0.05$).⁶ This result is similar to that of our study. In addition, the vitamin C concentration of aqueous was found to be lower than in the healthy population.

In the study reported here, the vitamin C concentration of plasma was not related to age. This is in agreement with the study of Birlouez-Aragon et al, in which the vitamin C concentration of plasma was measured in old people living in a nursing home and old people living at home.²¹ These researchers concluded that lack of vitamin C in the first group was related to environmental factors rather than their age. In our study, vitamin C concentration decreased as age increased, but the decrease was not statistically significant ($p = 0.179$).

Although some researchers have noted that senile cataract is more prevalent in women than in men,⁸ this difference was not statistically significant in our study. However, when the vitamin C concentration of plasma was compared in both sexes, the

difference was statistically significant with a higher concentration in women than in men ($p = 0.043$). One reason for this difference could be that women were at home more than men and foods with a high content of vitamin C may have been more readily available. There were no statistically significant differences in vitamin C concentrations of plasma and aqueous among different professions in our study. It may be that the different professions received similar amounts of vitamin C or that distinction among the different professions was not made for this study, as it is known that cataract is more prevalent in professions in which people are exposed to UVB and infrared rays.¹

Tessier et al studied the vitamin C concentration of operated lenses and its relation to the intensity of lens turbidity.¹¹ These researchers found that vitamin C concentration decreases as lens turbidity increases and concluded that vitamin C concentration in the lens is a good indicator of cataract intensity. We compared the relationship of different types of cataract, including mature, hypermature, cortical, and posterior subcapsular cataract, and vitamin C density of aqueous and plasma but our findings did not show any statistically significant differences.

Epidemiologic studies have shown that antioxidants such as vitamin C have a preventive role in chronic diseases such as cataract,^{4,12,13,18-20,22,23} cardiovascular disease, and certain cancers, and a daily dose of 90 to 100 mg of vitamin C for women and non-smoking men is advised to help prevent these conditions. This study showed that the vitamin C concentrations of aqueous and plasma in patients who have cataract are lower than normal. In areas where there is a high level of sunshine such as Iran, foodstuffs that are rich in vitamin C should be consumed to help prevent or delay the onset of cataract. This approach is cheap, reliable, and practical.



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