

OXIDATIVE STRESS AND ANTIOXIDANTS IN PATIENTS WITH SENILE CATARACT

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Abstract

Background: Senile cataract is an ever-increasing visual problem that accounts for approximately 50% of blindness worldwide. The development of age-related cataract is a slow process; the exact mechanism of cataract formation has not been clearly defined. There is increasing evidence that oxidative stress has been implicated in the development of age-related cataract.

Aim: To evaluate the serum levels of antioxidative enzymes and the products of oxidative stress in patients with senile cataracts and investigate the role of oxidative stress in senile cataractogenesis.

Method: Fifty patients with senile cataract and fifty healthy controls of matched age and gender were included in this study. Serum samples were obtained to measure the levels of antioxidative enzymes - superoxide dismutase (SOD) and catalase (CAT) as well as levels of oxidation Stress markers- Sialic acid and malondialdehyde (MDA).

Results: Serum SOD and CAT activities in the cataract group were significantly decreased as compared to the control subjects ($p < 0.001$). The levels of MDA and sialic acid in cataract patients were significantly higher than those in the control subjects ($p < 0.05$).

Inference: Oxidative stress is an important cause of senile cataractogenesis.

INTRODUCTION:

Any opacity in the lens or capsule, whether developmental or acquired, is called a cataract. (1) Cataract is the leading cause of preventable blindness in India. The most common form is senile/age-related cataracts. For this type of cataract, various studies have suggested the probability of involvement of a complex pathogenic mechanism which includes age, lifestyle and socioeconomic status but exact etiopathogenesis is not established yet (2). Increasing evidence suggests that oxidative damage of the lens proteins is implicated in the development of age-related cataracts. [3–6].

OBJECTIVE:

This study has been done to evaluate the serum levels of antioxidative enzymes and oxidative stress products in patients with senile cataract and investigate the role of oxidative stress in senile cataractogenesis.

MATERIALS AND METHOD:

This was a hospital-based case-control study for 12 months on patients attending Ophthalmology OPD of a tertiary care center in Eastern India. Fifty patients with newly diagnosed senile non-pathological cataract were recruited for the cases group. Patients with secondary cataracts due to diabetes, trauma, steroid administration, and other causes were excluded. Fifty healthy, age and sex-matched subjects were included for the control group. The control subjects were recruited from subjects who came to the same hospital with some ocular disease other than cataract. The control subjects were free from disease as determined by physical examination, blood pressure and normal levels of blood glucose and lipid profile parameters.

Venous peripheral blood samples (10 mL) were collected after 12 h overnight fasting from each subject in proper aseptic technique. The serum/ plasma was separated after centrifugation. All the tests were done with serum obtained from clotted blood except the test for estimation of plasma glucose which was done in citrated and fluoridated samples.

Serum sialic acid was measured by modified Aminoff's Method- a colorimetric method based on periodate oxidation followed by reaction with Thiobarbituric acid. The absorbance of the final chromophore is measured at 549 nm.

Serum MDA was measured as thiobarbituric-acid-reacting substance (TBARS) production whose absorbance at 532 nm was determined. The amount of TBARS was calculated from a comparison with authentic malondialdehyde. [7]

The activity of SOD measurement was based on the oxidation of NADPH by superoxide radicals. The oxidation of NADPH which is proportionately inhibited by the activity of SOD was monitored by absorbance at 540 nm. The Bovine erythrocytic SOD was run as a standard for each plate.

The serum activity of CAT was measured by using the Catalase Colorimetric Assay Kit of Invitrogen by Thermo Fischer Scientific.

RESULTS:

Data are presented as mean \pm SD. The statistical significance was evaluated using unpaired Student's *t*-test. Results were considered significant at $p < 0.05$.

PARAMETER	CASES	CONTROLS	p value
Sialic acid ($\mu\text{g}/\text{mg}$)	3.27 ± 0.39	2.12 ± 0.23	< 0.05
MDA (nmol/ml)	3.78 ± 1.09	3.25 ± 1.02	< 0.001
SOD (U/ml)	2.31 ± 0.02	1.10 ± 0.03	< 0.001
CAT (U/ml)	0.57 ± 0.02	0.29 ± 0.01	< 0.001

As shown in the table we found significant depression of serum antioxidative enzymes as well as a significant increase in serum MDA and sialic acid levels in patients compared with normal subjects.

DISCUSSION:

Oxidative stress is essentially an imbalance between the antioxidant system and the amount of reactive oxygen species (ROS) [9]. Molecules like the superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), and hydroxyl radicals, are detoxified by enzymes such as superoxide dismutase (SOD),

catalase (CAT), and glutathione peroxidase (GSH-Px). With increased oxidative stress, homeostasis is disturbed and damage to various biomolecules occurs.

ROS which is most commonly produced within the mitochondria in lens epithelium cells is highly reactive causing damage to macromolecules in living cells. The lens epithelium cell (LEC) is the centre of metabolic activities in lenses, and oxidative damage to LECs plays a significant role in the pathogenesis of many forms of cataracts [10].

Sialic acid, being an essential component of glycoprotein and glycolipids becomes an essential component of the cell membrane also. Thus, an elevated level of sialic acid in blood indicates cell membrane damage, especially, that of small vessels. [11]. An increased level of sialic acid is favoured by the process of desialylation. Several studies showed that the removal of terminal sialic acid moiety occurred due to increased oxidative stress [12]. Thus, inflammation and oxidative stress both play pivotal role in increased serum sialic acid level. It is already reported from the studies that presence of cataract is associated with the increase in serum sialic acid level [13].

Many biomarkers like lipid peroxidation, protein oxidation and DNA oxidation products have been developed to evaluate oxidative stress. Oxidation of proteins, lipids, and DNA has been observed in cataractous lens [14]. Lipid peroxidation by free-radical attack of membrane lipids produces large amounts of reactive products, which have been strongly correlated in cataractogenesis[15]. MDA is a product of the breakdown of mainly unsaturated fatty acids into their essential chains through the oxidation mechanism. Studies have revealed increased lipid peroxidation products like MDA in human cataractous lenses [16].

Reduction in antioxidative enzymes which protect the lens from oxidative stress and maintain lens clarity increases the risk of oxidative damage to the lens causing cataracts. Studies have shown that the activity of SOD, GSH-Px, and CAT decreased in cataracts [17] which is consistent with our findings.

CONCLUSION:

In the present study, we found that there is a significant imbalance between oxidative stress and antioxidative systems in serum in senile cataract patients. Compared with the control group, the activities of SOD and CAT in the cataract group were lower than those in the control group and the oxidative stress products MDA and sialic acid were significantly increased. Our results confirm that oxidative stress is an important cause of cataractogenesis and for preventing or delaying the onset of cataract formation, augmentation of the antioxidant defenses is necessary.

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