

# To assess the levels of zinc in serum and changes in the lens of diabetic and senile cataract patients

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## Abstract

**Objective:** To assess the levels of zinc in serum and changes in the lens of diabetic and senile cataract patients

**Methods:** A comparative cross sectional study was done at LRBT (Layton Rehmatullah Benevolent Trust) free eye hospital Mandra from July 2010 to August 2010. Twenty Type 2 diabetic patients with cataracts and 20 patients without diabetes of senile cataract were included in the study. Glucose levels were determined by glucose oxidase method and zinc levels measured by colorimetric method (RANDOX).

**Results:** The statistical analysis showed a statistically significant decrease in zinc levels in diabetic patients with cataract when compared to individuals with senile cataract ( $P < 0.05$ ). In senile lenses multilayering of cells, wrinkling of the lens capsule, and apoptotic cell death were seen, but in diabetic lenses number of cells decreased and cells were smaller as compared to senile lenses. The results were not statistically significant  $P > 0.05$ .

**Conclusion:** Our findings in this study show a relationship between zinc deficiency and increased occurrence of cataract among people with diabetes.

**Keywords:** Diabetes, Senile, Cataract, Zinc (JPMA 61:853; 2011).

## Introduction

With disease duration longer than 20 years, in 95% of type 1 diabetic and 60% of type 2 diabetics signs of diabetic retinopathy start appearing.<sup>1</sup> Cataract is considered a major cause of visual impairment in diabetic patients. One of the most common consequences of the aging process is the development of senile cataract. It usually starts developing in those over 45 years of age. Approximately 75 percent of population over 75 suffers from senile cataract, which is the major cause of poor vision and blindness in the world. The normal lens is translucent and elastic. If there is damage to either the lens fibers or if the normally translucent crystallin proteins aggregate then the lens becomes opaque and light is either diffused or blocked.<sup>2</sup>

Multiple mechanisms for cataract formation have been implicated such as osmotic graduation, protein aggregates, oxidative stress and post translational protein changes, but the exact pathogenesis is not known.<sup>3</sup>

In diabetes in addition to increased levels of free radicals, there is an impaired antioxidant activity in the lens also, increasing their susceptibility to oxidative stress. The loss of antioxidants is aggravated by glycation and inactivation of lens antioxidant enzymes like superoxide dismutase.<sup>4</sup>

Zinc is the second most abundant trace element in the human body, and the total content is approximately two grams.<sup>5</sup> Zinc is also required as a catalytic, structural

and regulatory ion for the activity of many enzymes against oxidative stress including superoxide dismutase (SOD).<sup>6</sup> Superoxide dismutase 1 (SOD1) is the most dominant superoxide dismutase isoenzyme in the lens which is important for the degradation of superoxide radicals into hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and oxygen. It requires zinc for its catalytic activity.<sup>7</sup> The aim of this study was to assess the level of zinc in diabetic and senile cataract elderly patients.

## Patients and Methods

This was a comparative cross sectional study. An informed written consent was obtained. Blood samples and lenses were collected from patients of LRBT free eye hospital Mandra. Tests were performed in the Biochemistry department in collaboration with the Anatomy department of Islamic international medical college, Rawalpindi. Twenty Type 2 diabetic patients with cataracts and 20 patients of senile cataract were included in the study. Senile cataract patients served as a control group for the patients with diabetic cataract. They were examined by an expert ophthalmologist and routine ophthalmic examinations including visual acuity determination, slit lamp examination, ophthalmoscopy and intraocular pressure measurement were done for all the patients. The mean age of the diabetic patients was similar to that of senile cataract patients. Both genders were included in the study. Criteria for patients selection was Type 2 diabetic patients with

random blood glucose levels  $\geq 200$  mg/dl with symptoms such as polyuria, polydipsia, polyphagia and fasting blood glucose  $\geq 126$  mg/dl. Patients with history of any antibiotic therapy within six months prior to study, history of any systemic disease for the senile group, history of any systemic disease other than diabetes for the test group, subjects who were pregnant and pre eclamptic, those with a history of smoking, tobacco consumption, those taking vitamin supplements, patients suffering from age-related cataract with any other ophthalmologic disease or any past history of ophthalmic surgery were excluded from the study.

5 ml of blood was drawn for determining the serum levels of blood glucose and zinc in the morning after 12 hours overnight fast from both the groups in their first visit to the eye OPD. Blood was kept at room temperature and then centrifuged at 10,000 rpm for 10 minutes and serum was pipetted. Test applied for the detection of glucose was glucose oxidase method and for zinc was colorimetric method (manual) by RANDOX performed on vitalab Selectra E (Nederland). After surgery lens was extracted and preserved in 10% formalin for 48 hours. After processing for paraffin blocks 5 micrometer thin sections were cut and mounted sections were stained with haematoxylin & eosin (H&E) stain. At 40x objective lens these slides were studied to see histological changes in lens fibers.

The analyses were carried out with SPSS 17 statistical software and the data expressed as means  $\pm$  standard deviations. Quantitative data was analyzed using independent samples t- test.  $P < 0.05$  was taken as significant. Results of the histological examination were analyzed by the chi-square test.

## Results

The mean duration of the disease was  $11.8 \pm 6.8$  years. The group statistics for FBS levels showed a mean of  $212.6 \pm 14.95$  mg/dl for diabetic patients with cataract and a mean of  $69.9 \pm 10.9$  mg/dl for individuals with senile cataract which was significant  $P < 0.05$ .

The group statistics for zinc levels showed a mean of  $68.6 \pm 8.49$   $\mu$ g/dl for diabetic patients with cataract and a mean of  $96.07 \pm 12.41$   $\mu$ g/dl for individuals with senile cataract, which was also significant  $P < 0.05$ .

## Histological findings:

Lens of diabetic etiology showed lamellated bands of lens fibers of different density. Microscopic studies show that the cytoplasm of some lenses appeared more granular in texture as compared to the controls. As per the present study deepening of the colour was observed in senile cataract lenses.

In senile lenses abnormal migration and multilayering

**Table: Comparison of number of cells in both the groups.**

groups	N	Mean	p- value
Senile	20	$19.00 \pm 1.15$	$> 0.05$
diabetic	20	$15.07 \pm 0.92$	

of cells, wrinkling of the lens capsule, and apoptotic cell death were noted, but in diabetic lenses number of cells decreased and cells were smaller as compared to senile lenses, the results were not statistically significant  $P > 0.05$  (Table).

## Discussion

Between 45-65% of blindness worldwide is attributable to cataract. Cataract is the opacification of the crystalline lens, which may result in visual impairment and subsequent blindness. Incidence of cataract is high in developing countries where nutritional deficiencies are more prevalent. Zinc is a trace element essential in human nutrition. Its presence is significant in membrane function and cellular metabolism. Deficiency of zinc may be due to decrease intake, metabolic disorders, poor absorption and medication. Zinc protects from early onset of cataract, optic neuritis and retinal degenerations. Zinc protects all the tissues in the eye against oxidative damage.<sup>8</sup> Superoxide dismutase (SOD) is a major antioxidant enzyme, which plays a vital role in clearance of reactive oxygen species (ROS). It has 3 isoforms, among the isoforms superoxide dismutase 1 is copper-zinc containing and is localized in the intracellular cytoplasmic compartments.<sup>9</sup> Our study showed that zinc levels are deficient in diabetics as compared to non-diabetics, and the histological changes in the lens of both types of patients were also significantly different. This means that oxidative damage is more pronounced in diabetics because of the defective function of SOD due to zinc deficiency which leads to more pronounced lipid peroxidation. This correlates with the studies carried out by Olofsson et al<sup>10</sup> which showed accelerated cataract formation in the diabetic SOD1-null mice and suggests the involvement of superoxide radical ( $O_2^{\cdot-}$ ) in diabetes-induced cataract development. The lens damage and cataract formation appears to be due to in-situ generation of active species of oxygen. These oxygen derivatives may contribute to the multifactorial process of senile cataract formation also.<sup>11</sup> Senile cataracts have been associated with a number of systemic illnesses, like allergy, pneumonia, coronary disease, hypotension, hypertension, mental retardation, and diabetes. The most common corrective procedure for cataract in the world is cataract surgery. Scientific data show that cataract progression can be delayed by 10 years and this will reduce the number of surgeries by 45% .This can be achieved by improving the nutritional status of the elderly.<sup>12</sup> Our findings in this study

show a relationship between zinc deficiency and increased occurrence of cataract among the elderly. This deficiency may be due to under-utilization and malutilization of Zinc in the diet and lack of supplementation for zinc.

The well-defined lamellations of different density in diabetic cataract lens may be associated with varied glucose levels.

There is an inverse correlation between plasma Zn and age. It has been reported that decreases in serum Zn levels are associated with ageing and other disease states. Thus, Zn could play a key role as antioxidant in aging.<sup>13</sup> With aging the water content of the lens decreases and more soluble protein becomes insoluble and the concentration of calcium increases, this causes opacity of the lenses.<sup>14</sup> In our study it was observed that the senile cataract lenses had more pronounced changes as compared to the diabetics. In the studies done previously by Vrensen et al, three age related changes were observed. Ruptured membrane, water vacuoles and multilamellar bodies in the senile lenses.<sup>15</sup> These findings are in accordance with our studies. In case of diabetics lenses in previous studies different lamellar bands in lenses have been attributed to raise blood glucose levels.<sup>16</sup> This is also seen in our present study. Many biochemical mechanisms by which zinc influence cell metabolism need to be explored. However, some of these biochemical and physiological mechanisms can be explained on the basis of deficiency states and for this purpose further studies need to be done on the potential of zinc in the prevention of cataract occurrence.

### Conclusion

The study findings show a significant decrease in the levels of zinc in the diabetic group as compared to senile group. Further electron microscopic studies and assessment of zinc levels in both types of lenses can confirm manifestations of zinc deficiency that leads to early histological changes in lenses.

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