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## **Estimation of serum calcium and phosphorus levels in male cataract patients: A case control study**

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**Abstract**--Introduction: Cataract is vision-impairing disease marked by incremental, progressive lens thickening. The lens is composed of G-protein receptors that are linked to intracellular calcium release. Through the activation of calcium dependent proteases, elevated calcium levels can indicate metabolic disturbances and cell component disruption. The Na<sup>+</sup>-K<sup>+</sup> ATPase pump's activity in maintaining a low cytoplasm Ca<sup>2+</sup> concentration increases calcium levels significantly, causing rapid lens fibre breakdown, uncontrolled protein breakdown, cell swelling, and opacification. Phosphorus is involved in membrane permeability of the lens. The objective of the present study was to estimate and compare the serum calcium and phosphorus levels in males diagnosed with cataract and without cataract. Methodology: A total of 110 subjects were studied, of which 55 were diagnosed cataract patients and 55 were controls with no signs of cataract on ophthalmologic examination. Serum calcium and phosphorus were estimated. The obtained data was analysed statistically. Independent t test was used to associate the parameters. Results: In our study we found significantly increased levels of serum calcium in cataract patients (p<0.05) as compared to controls. Serum phosphorus concentration in cataract patients (p<0.05) was significantly increased as compared to controls. Conclusions: We conclude that cataract patients presented with high levels of serum

Calcium and Phosphorus levels as compared to controls. Tracking these parameters at regular intervals can be beneficial in extending the period of obvious cataract development that requires medical intervention.

**Keywords**---cataract, G-protein, Na<sup>+</sup>-K<sup>+</sup> ATPase, calcium, phosphorus.

## **Introduction**

The eye is a delicate organ with so many small parts, and each one is essential for optimal vision<sup>2</sup>. The lens is an avascular, translucent, biconvex structure which plays an important role in vision. Because of its high refractive index, it can perform its work efficiently, in which its biconcave shape also plays a major role. The higher protein content in human lenses contributes for the higher refractive index. Cataract is vision-impairing disease marked by incremental, progressive lens thickening<sup>1</sup>. The clouding or opacity that occurs in the eye lenses is defined as cataract. When the attachment or folding of a protein shifts and clumps together, cataract develops. These clumps often induce clouding in the lens that prevents entry of light<sup>3</sup>. Towards the onset of cataract, the lens is more susceptible to oxidative damage from ROS. Cataracts and cataract surgery have a great economic impact. As a result, researchers are extremely interested in knowing more about role of molecular, biochemical processes in cataractogenesis<sup>4</sup>. Calcium and phosphorus cause membrane damage, protein-lipid alteration and aggregation, inflammation, and lenticular apoptosis, modify the refractive properties of the lens, resulting in opacity and cataract formation<sup>5,6</sup>. Elevated serum calcium levels cause increased permeability, which leads to increased intralenticular calcium concentration, proving to be a significant risk factor for cataractogenesis<sup>7</sup>. Our study aimed to estimate the serum calcium and phosphorous levels in male cataract patients, so that these parameters if found deranged can be implied as the tracking or pre diagnostic tools.

## **Methodology**

A total of 110 subjects were studied, of which 55 were diagnosed cataract patients and 55 were controls with no signs of cataract on ophthalmologic examination. Serum calcium and phosphorus were estimated respectively by Orthochresolphthalein Complexone and Fiske Subbarow method. The obtained data was analysed statistically. Independent t test was used to look for association between the parameters.

In our present study we included only male individuals as study participants because the physiological hormonal imbalance in females of postmenopausal stage have showed decreased calcium & phosphorus levels due to the process of bone resorption. Oestrogens are found to be protective against the different types of cataracts as studied by the Klein, B.E.K. Madison (1994)<sup>19</sup>. Similar study by Jose M Benitez del Castillo (1995) was aimed to substantiate the protective effect of oestrogens in the lens opacities and proved beneficial effects of oestrogen levels among the postmenopausal women lenses<sup>20</sup>. Patients diagnosed with DM, CVS<sup>21</sup>, RA & Major disorders<sup>22</sup> presenting with cataract were excluded from the

study because these disorders have great impact on homeostasis and electrolyte balance in the body and therefore no proper correlation can be drawn in these individual.

## Results

Table 1: Comparison of cases and controls with age (mean) by independent t. test

Group.	n	Mean	SD	SE	t.-value	P-value
Cases	55	55.65	6.10	0.82	4.5159	<0.001, S
Controls	55	49.84	7.36	0.99		

Table 2: Comparison of cases & controls with mean serum calcium (mg/dL) levels by independent t. test

Group.	n	Mean.	SD.	SE	t. value	P. value
Cases	55	10.49	0.59	0.08	4.4283	<0.001, S
Controls	55	9.95	0.69	0.09		

Table 3: Comparison between cases & controls with mean Phosphorus (mg/dL) levels by independent t. test

Group.	n	Mean.	SD	SE	t. value	P. value
Cases	55	4.66	0.91	0.12	6.3616	<0.001, S
Controls	55	3.64	0.76	0.10		

## Discussion

Calcium and phosphorus cause membrane damage, protein-lipid alteration and aggregation, inflammation, and lenticular apoptosis, modify the refractive properties of the lens, resulting in opacity and cataract formation<sup>5,6</sup>. Elevated serum calcium levels cause increased permeability, which leads to increased intralenticular calcium concentration, proving to be a significant risk factor for cataractogenesis<sup>7</sup>. Our study aimed to estimate the serum calcium and phosphorous levels in male cataract patients, so that these parameters if found deranged can be implied as the tracking or pre diagnostic tool. In the present study we found higher levels of serum calcium & phosphorus levels in patients compared to control group. Our results are statistically significant (P value< 0.001). Our data contradict the claims of Italian –American Cataract study group that there is no relationship between the blood biochemical constituents & cataract<sup>10</sup>.

Study conducted by the B N Consul, SS Charan, RG Sharma. India (1970) has found the average serum calcium in normal cases was 11.21 mg/100mL, and in cataractous cases it was 11.36 mg/100mL, with no noticeable difference between the two. There was no difference in serum calcium levels between normal and cataractous patients<sup>11</sup>.in contrast we have found higher serum calcium & phosphorus levels in cataractous patients.

Clark et al established that ion balance is a critical functional element in preserving lens transparency.  $\text{Ca}^{2+}$  and  $\text{Na}^+$  distributions were found to be elevated in the cataract lens, whereas  $\text{K}^+$  distributions were poor, presumably due to calcium influencing cell membrane permeability and reducing  $\text{Na}^+\text{-K}^+$  ATP enzyme activity. As a result, potassium and sodium ion channels open secondary, causing sodium retention and increasing light scattering, gradually leading to lens opacity<sup>12</sup>. Our results build on existing evidence of that the normal concentration of serum calcium is necessary for maintaining lens transparency.

In the present case- control study serum calcium & phosphorus levels were estimated in 55 individuals who are diagnosed with cataract & 55 individuals who do not have cataract on examination. Our study results indicate the higher levels of serum calcium and phosphorus in cases when compared to controls in contrary to hypothesis proposed by Aniq Mansoor et.al. in Pakistan (2015)<sup>13</sup> & Rehab OM Altouhami, Abdalla E Ali (2018)<sup>14</sup> which shows statistically significant lower serum calcium levels in both the cases & controls. Our findings indicate that serum calcium and phosphorus levels in cataract patients vary. This variation could be due to regional differences & also the Dietary factors which vary across the different parts of the world.

Studies conducted by the Mansour Mirsamadi, Issa Nourmohammadi in Iran (2003) suggested that increased serum calcium levels in patients diagnosed with the cataract are the predisposing factors for the cataractogenesis<sup>15</sup>. Statistically significant decreased serum calcium & phosphorus was found in our study compared to Smita A Deokar et.al. (2018)<sup>16</sup>. Study conducted by the Chan Joong Kim, MD, Sang Kyung Choi, MD (2007) Calcium levels in serum did not vary statistically between non-diabetics and diabetics. The phosphorus level did not vary greatly either. Although calcium levels in the aqueous humour did not vary significantly, phosphorus levels in diabetics were significantly higher than those in non-diabetics. Calcium levels in serum and aqueous humour did not vary between non-diabetics and the three diabetic subgroups, but phosphorus levels in diabetics with proliferative diabetic retinopathy were significantly higher than those in non-diabetics, diabetics without diabetic retinopathy, and diabetics with non-proliferative diabetic retinopathy<sup>17</sup>. In comparison we have found statistically significant calcium & phosphorus ( $P < 0.05$ ) in case subjects (23,24).

The analyses demonstrated by Daxin Tang et.al. in Italy ( 2003 ) shows that increased intracellular calcium concentrations and a reduced ability of lens lipids to bind to calcium set off a chain of events that results in increased light scattering from lipids and, in particular, proteins. Calcium binding to lipid membranes does not lead directly to light scattering in cataractous lenses. It has been proposed that the majority of the diffusible calcium in the lens is in the intercellular spaces, and that lens lipids in the bilayer's outer leaflet bind to that calcium<sup>18</sup>. If this is the case, our data correlates with that increased levels of calcium & phosphorus in the serum of patients.

## **Conclusion**

There is a significant increase in serum calcium and phosphorus levels in male patients with cataract as compared to those without cataract, implying that

tracking these parameters at regular intervals can be beneficial in extending the period of obvious cataract development that requires medical intervention. Further research is required to establish the specific exact role of calcium & phosphorus in cataractogenesis.

Conflict of Interest – There are no conflicts of interest in this study

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