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SENILE CATARACT PATIENTS;
SERUM ELECTROLYTES AND CALCIUM

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ABSTRACT… Purpose: The current study was aimed at finding out the significance of serum electrolytes and serum calcium levels in the development of senile cataract. **Study Design:** Case control study. **Setting:** Ghurki Trust Teaching Hospital, Lahore, Pakistan. **Period:** Jan 2013 to June 2013. **Methods:** Total fifty patients with senile cataract and fifty controls were selected. Clinical history and clinical diagnostic tests were performed by an ophthalmologist. Blood samples were drawn and serum stored at -20° C. Serum potassium and sodium were measured by Flame photometry. Serum chloride levels were estimated by quantitative displacement of thiocyanate by chloride. The estimation of calcium was done using photometry by CPC method. Statistical analysis was done by Statistical package for social sciences (SPSS version 16.0). There were 31 females and 19 male (F:M = 1.63:1) patients. In the control group, there were 32 females and 18 males (F:M = 1.77:1). The age was ≥ 40 years in both patients and control group. **Results:** Nuclear cataract was the commonest. Among all the analytes, only serum calcium levels were found to be significantly lower in patients (p value less than 0.05 as compared to controls). While difference of sodium, potassium and chloride levels between cases and controls was insignificant. (p values 0.49, 0.36, and 0.45 respectively). **Conclusions:** In Pakistan, serum electrolytes in cataract patients are not significantly different from the controls while serum Calcium of cataract patients is significantly low when compared with the control group, indicating the possible role of low calcium level as a risk factor in the development of senile cataract.

Key words: Serum electrolytes, Serum calcium, Nuclear cataract, Cortical cataract, Posterior sub-capsular cataract

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INTRODUCTION

Eye is the most amazing organ in the human body, and Lens is one of the most notable structures within it. The transparency of the crystalline lens has been attributed to complex, ordered arrangement of its components at both microscopic and molecular levels. The main function of the lens is to refract the light to focus it on the retina. Any opacification in crystalline lens is called cataract. Cataract accounts for over half of the cases of blindness in Pakistan.[1] Senile Cataract, a physiological disorder of the eye occurring in the elderly persons, is characterized by an initial opacity in the lens, subsequent swelling of the lens and final shrinkage with complete loss of transparency.[2]

Clinically, senile cataract is divided into Nuclear, Cortical and posterior sub-capsular. Normal serum electrolytes are required to maintain proper water electrolyte balance all over the body. The purpose of this study is to find out whether serum electrolytes and calcium levels have some role in the formation of different types of senile cataract in Pakistani patients.

PATIENTS AND METHODS

A case control study was designed, in which hundred subjects (50 patients and 50 age matched controls) were selected from Ghurki Trust Teaching Hospital, Lahore, Pakistan (from Jan 2013 to June 2013). The current project was approved by Institutional Review Board. Clinical history, including ocular as well as systemic history, was taken. Ocular examination included distance and near visual acuity, pupillary reactions to light and accommodation, Slit lamp Biomicroscopy, Oph-

thalmoscopy and Tonometry. All these clinical diagnostic tests were performed by an ophthalmologist. Procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation with the Helsinki Declaration of 1975, as revised in 1983.

INCLUSION CRITERIA

The inclusion criteria for the current study were; male/female patients having senile cataract, non-smokers and age ≥ 40 years.

EXCLUSION CRITERIA

Patients with secondary Cataract and having any systemic disease were excluded from the study. Controls were healthy individuals visiting Ghurki Trust Teaching hospital for Presbyopic glasses. They were without any ocular or systemic disease. Aseptic precautions were taken to draw blood from the subjects. Serum was separated from all blood samples and stored at -20°C. Patient proforma and consent forms were filled before sampling. Serum sodium and Potassium were estimated by Flame Photometry (Model FP 10). Concentration of Sodium and Potassium were calculated by the following formula:

$$\text{Concentration} = \frac{\text{Test Absorbance}}{\text{Standard Absorbance}} \times \text{Standard Concentration}$$

Chloride estimation was done by quantitative displacement of thiocyanate by chloride from mercuric thiocyanate and subsequent formation of a red ferric thiocyanate complex, which was measured colorimetrically. The intensity of color formed was proportional to the chloride ion concentration in the sample (Company Pioneer Diagnostics, Catalog # PD-2701).

$$2\,Cl^- + Hg(SCN)$$
$$HgCl2 + 2\,SCN^-$$
$$SCN^- + Fe^{+++} \; FeSCN^{++}$$

Concentration of Chloride was estimated by the following formula:

$$\text{mmol/L of chloride in sample} = \frac{\text{Absorbance of Sample}}{\text{Standard Absorbance}} \times 125 \text{ (Standard concentration)}$$

Estimation of calcium was done using photometry by CPC method (Kit Company Human, Catalog # 10011). Calculation of the calcium concentration was done by the following formula:

$$\text{Concentration of Calcium} = \frac{\Delta \text{ A Sample}}{\Delta \text{ A Standard}} \times 8$$

(Δ A= Change in absorbance)

The statistical analysis was done by using SPSS version 16.0.

RESULTS

In the current study, there were 31 females and 19 males (F:M = 1.63:1). The types of senile cataract were Nuclear, Cortical and Posterior sub capsular. Patients who had more than one type of lens changes were categorized according to the more prominent type of lens change. Among all the types, Nuclear Cataract was the commonest (Figure-1). In the control group, there were 32 females and 18 males (F:M = 1.77:1). There were 39 patients with Nuclear Cataract, 8 patients with cortical cataract and 3 had posterior sub capsular lens changes. The details of analytes studied in all these patients are shown in Table-I.

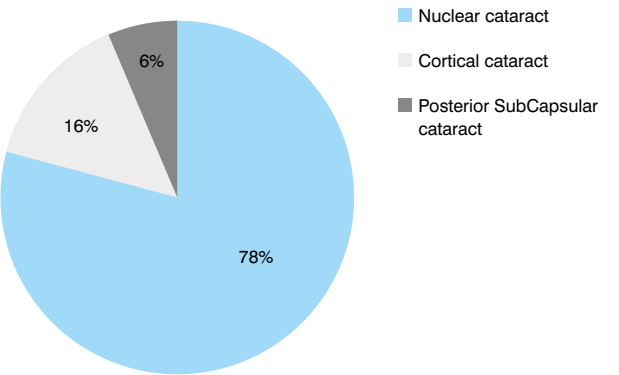

Figure-1. Percentage of different types of senile cataract.

When serum electrolytes of patients were compared with control, the p-value of Sodium, Potassium and Chloride was non-significant (NS). The p-value of calcium was observed to be significant (*) as shown in Table-II. Odd ratios for all analytes were calculated for different cataract types (refer to Table-III). Only Ca had significant odd ratio for Cortical & Nuclear cataract. It indicated that high level of Ca had a protective effect.

Number of patients												
Types of Senile Cataract	Na			K			Cl			Ca		
	Normal	High	Low	Normal	High	Low	Normal	High	low	Normal	High	Low
Nuclear	34	2	3	37	0	2	36	0	3	22	0	17
Cortical	7	1	0	7	0	1	7	0	1	3	0	5
Posterior Sub Capsular	3	0	0	3	0	0	3	0	0	0	0	3

Table-I. Number of patients with normal, high or low values of different Analytes

Parameter	Groups	Mean	Median	Std. error of mean	Minimum	Maximum	p-value
Na (135-150 mmol/L)	Control	142	141	0.71	132	152	0.49
	Patients	141	141	0.69	133	151	
K (3.5-5.5 mmol/L)	Control	4.1	4	0.05	3.2	5.1	0.36
	Patients	4.08	4	0.05	3.4	5	
Cl (95-115 mmol/L)	Control	101	101	0.45	93	107	0.45
	Patients	100	101	0.59	90	107	
Ca (8.1-10.4 mg/dl)	Control	8.88	8.9	0.11	7.3	10.5	<0.05*
	Patients	8.19	8.05	0.08	7.3	10	

Table-II. 'p' value in senile cataract patients and control group
** shows significant*

DISCUSSIONS

Various studies are going on all over the world to clarify the relationship between human biochemical elements and cataract formation. So far, different mechanisms have been identified, such as osmotic gradient, protein aggregation, oxidative stress, and nutritional factors.[3] Our study is consistent with the Italian-American cataract study, where no relation between blood biochemical elements and cataract was found[4]. There are other studies which have shown variable results of serum sodium and potassium in cataract patients. This variability can be the result of different dietary habits in different areas of the world or may be due to nutrition quality in nations all over the world.

In contrast to this, in 2013, Mathur and Pai described a prospective case-control study, in which, mean sodium levels among senile cataract patients were significantly higher than control group.[5] The difference in mean potassium between the two groups was statistically insignificant. Authors concluded that diet with high sodium content was a risk factor for senile cataract formation and dietary modifications could possibly reduce the rate of progression of cataract. Similarly, in Italy, a study revealed strong association of high serum Sodium and Potassium levels with cortical cataracts.[6] Whereas, another study showed reduced serum Potassium in cortical cataract.[7]

Strikingly different results were seen in a study in Iran where Mean serum Na^+ level in the patients was significantly ($P<0.05$) lower than the control groups (44.0 ± 2.13 vs. $49.7\pm2.5\ \mu g/dl$). No significant difference regarding K^+ levels was seen in both patient and control groups[8]. Contrary to that, another study of Iranian population revealed that, mean serum Na^+ level in senile cataract patients was high and statistically significant ($p<0.0001$). While mean serum K^+ level in senile cataract patients showed no statistically significant difference.[9] Similarly, in Indian population, serum sodium levels in cataract group were statistically significant and mean potassium between the two groups was statistically insignificant.[10] According to Duncan and Bushell, nuclear cataracts had a near normal range of concentrations of sodium,

	Analytes		Control	Patients	Odd Ratio (CI 95%)
Sub capsular Cataract	Na	132-142	50	3	------
	K	3.2-4.3	40	2	2.0 (0.16-24.3)
		4.4-5.5	10	1	
	Cl	90-100	18	2	0.281(0.024-3.3)
		101-115	32	1	
	Ca	7.5-8.5	15	3	0.071(0.003-1.51)
		8.6-10.4	35	0	
Total			50	3	
Nuclear Cataract	Na	132-142	30	26	0.75 (0.313-1.797)
		143-152	20	13	
	K	3.2-4.3	40	33	0.727 (0.239- 2.212)
		4.4-5.5	10	6	
	Cl	90-100	18	18	0.656 (0.279-1.542)
		101-115	32	21	
	Ca	7.5-8.5	15	31	0.111 (0.041-0.296)
		8.6-10.4	35	8	
Total			50	39	
Cortical Cataract	Na	132-142	30	3	2.5 (0.536-11.6)
		143-152	20	5	
	K	3.2-4.3	40	8	0.25 (0.01322-4.72)
		4.4-5.5	10	0	
	Cl	90-100	18	4	0.563 (0.125-2.52)
		101-115	32	4	
	Ca	7.5-8.5	14	6	0.133 (0.024-0.742)
		8.6-10.4	35	2	
Total			**50**	**8**	

Table-III. Odd ratio (CI 95%) for Na, K, Cl and Ca in different types of cataract.

potassium and chloride. However, mixed cataracts, had significantly raised sodium, lowered potassium concentration and a raised calcium concentration. Cortical and mature cataracts had increased sodium, calcium and chloride concentrations and a very low potassium level.[11]

In the present study, low serum Calcium was seen in 17, 5 and 3 patients of Nuclear, Cortical and Posterior Sub Capsular Cataract respectively. Mean serum calcium in patients was 8.19±8.08 and in control group was 8.88±0.11 with p value (0) which was highly significant. Low serum Calcium levels in the cataract patients, was seen in other populations as well, clearly supporting our results.[12,13]

Contrary to the above studies, Donnelly and his fellows found that Posterior sub capsular cataract was related to increased calcium.[14] Whereas, Iranian and Indian studies have shown no significant difference in Ca^{++} levels in both patient and control groups.[15,16] An animal model of hypocalcemic cataract was used to investigate the changes of the cation levels and the Ca^{2+} pump (Ca^{2+}-ATPase) function in the lens. It was concluded from the study that cataract during the early stage of hypocalcaemia is caused by membrane damage with low calcium level in the aqueous humor and sodium content increases in the lens.[17] Similarly, the cataract of parathyroid tetany is suggestive of the inter relationship between the serum calcium concentration and cataract. Calcium in the lens

is related with the normal permeability and regulation of dynamic equilibrium between the ionic constituents of the lens and its surrounding fluid.

When studies were done on Calcium levels within in the lens, cataractous lenses had a higher Calcium concentration than normal lenses in humans and animals.[18] It is said that an accumulation of Calcium in the intact lens induces formation of high molecular weight proteins, which may be associated with the loss of lens transparency.[19]

The results of different studies are diverse. Molecular research has shown that there are three types of ionic channels in the lenses. The smallest is the Calcium channel and the larger ones are for the sodium and potassium movements.[20] The transmembrane potential of human lens decreases with age. There is an increase in cation permeability, which is balanced by an increase in the pump activity (which removes Sodium and Calcium from the lens). Despite this, free sodium and calcium levels increase in cytoplasm of older lenses.

Lens expresses Calcium-stimulated ATPase and Ca-ATPase. Both are found in the lens epithelium and cortical fibers[21]. Ca-ATPase transports Calcium outward from the cytoplasm of the cells of the lens. Na-Ca exchange is also responsible for the inward flow of Sodium and efflux of Calcium from the lens. In addition, Calcium is removed from the cytoplasm by a different Ca-ATPase, localized on the surface of endoplasmic reticulum. The trans-membrane transport of cat ions is affected by the aqueous concentrations of these ions. Aqueous formation occurs as a result of ultra filtration and active transport from ciliary processes. Aqueous is the ultimate source of nutrition and other constituents for the lens. Any change in serum levels of these constituents will affect the aqueous levels which, in turn affects the lens metabolism.

As Sodium and Calcium channels are found in the lens epithelium, so their effect on lens transparency is more important. The fact that the results from different populations are variable indicates that whether the serum levels of Sodium, Potassium and Calcium are low or high, the efficiency of these channels is at stake. The ultimate result is the loss of lens transparency.[21] Normal serum electrolytes in the current study and some other previous studies can be explained by the fact that senile cataract is a multifactorial disease and there are other factors, which contribute to the aging lens changes.

In Pakistani population, serum electrolytes in cataract patients are not significantly different from the control while serum Calcium of cataract patients is significantly low when compared with the control group. Further research should be done to find out the exact role of Calcium in the development of cataract.

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3	Tayyaba Gul Malik	Study design & drafting manuscript	
4	Muhammad Khalil	Data analysis & revising	
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