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Biochemistry

A STUDY OF SERUM ELECTROLYTES AND GLYCEMIC STATUS AMONG PATIENTS OF SENILE CATARACT ATTENDING A TEACHING INSTITUTE OF NORTH-EAST INDIA

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ABSTRACT **Background & Objectives-** Cataract, particularly senile cataract, is a leading cause of blindness in developing countries. Although its exact cause is unclear, factors like age, sex, radiation, poor glycemic control, serum electrolyte changes are considered risk factors. The study aims to estimate serum electrolyte levels and glycemic status in senile cataract patients compared to age-matched individuals without cataracts. **Materials & Methods-** A hospital-based cross-sectional study was carried out in the Department of Biochemistry in collaboration with the Department of Ophthalmology at Agartala Government Medical College and Govind Ballabh Pant Hospital, Tripura, between January 2023 and June 2024. The study involved 100 senile cataract patients aged over 50 years and 100 age-matched healthy controls. Serum levels of sodium, chloride, potassium; fasting plasma glucose & glycated haemoglobin (HbA1c) were assessed. Statistical analysis was performed using the Student's t-test and Pearson's correlation test, with a p-value of less than 0.05 considered statistically significant. **Results:** A statistically significant increase in serum levels of sodium, chloride; fasting plasma glucose & HbA1c were observed in senile cataract patients compared to controls. **Conclusions:** Poor glycemic control may promote oxidative stress elevating serum electrolytes and cataract formation via the polyol pathway. Increased sodium and chloride levels can impair lens function, with high salt intake and osmotic diuresis worsening the imbalance. The study emphasizes the importance of monitoring serum sodium, chloride, fasting glucose, and HbA1c levels, along with dietary changes and good glycemic control, to help prevent or slow senile cataract progression.

KEYWORDS : Cataract, Electrolytes, Glycated haemoglobin, Glycemic control, Hypernatremia, Hyperchloremia

INTRODUCTION:

A cataract refers to the clouding of the eye's lens or its surrounding capsule, which may be present at birth or develop gradually over time. The most common form is senile cataract, which usually affects individuals over the age of 50 years. It progresses through stages, starting with lens opacity, followed by swelling, shrinkage, and eventually a complete loss of transparency.[1] According to WHO, cataract accounts for 33% of visual impairment and 51% of avoidable blindness globally. In India, the National Programme for Control of Blindness reports cataract as the cause of 62.6% of preventable blindness.[2] The exact cause of senile cataract remains unclear, with no single molecular explanation identified. However, recent studies suggest that factors such as corticosteroids, exogenous estrogen, nutrition, dietary fat, serum lipids and genetics may contribute to its development and progression.[3] The aqueous humor derived from serum nourishes the lens, which depends on it for proper metabolism. Imbalances in serum electrolytes can alter the aqueous humor's composition, disrupt lens function and potentially lead to cataract formation.[4] Glycemic status refers to the level of glucose in the blood, typically categorized as hyperglycemia or hypoglycemia. High blood glucose activates the polyol pathway in the lens, leading to osmotic stress, increased reactive oxygen species, and damage to lens fibers, which can contribute to cataract formation.[5] The study aims to assess serum electrolytes and glycemic status in patients with senile cataracts at AGMC & GBP Hospital. It seeks to provide insights into their relationship with cataract development to enhance prevention, diagnosis, and treatment strategies.

MATERIALS AND METHODS:

A hospital-based, observational, cross-sectional comparative study was carried out in the Department of Biochemistry in collaboration with the Department of Ophthalmology at Agartala Government Medical College & Govind Ballabh Pant Hospital, Agartala, Tripura, from January 2023 to June 2024. The study included 100 senile cataract patients over the age of 50 years, attending the Ophthalmology OPD, and 100 age-matched healthy controls. The sample size was calculated using OpenEpi software with a 95% confidence interval, 80% power, and a 1:1 group ratio, accounting for a 10% dropout rate. The study received approval from the Institutional Ethics Committee (IEC) of Agartala Government Medical College, and written informed consent was obtained from all participants.

Inclusion Criteria:

a) 100 patients with cataract attending the OPD of Department of Ophthalmology, Agartala Government Medical College & Govind Ballabh Pant Hospital, Agartala.
b) Patients aged above 50 years.
c) 100 age-matched healthy individuals.
d) Both sexes were included.
e) Those who were willing to take part in this study.

Exclusion Criteria:

a) Patients with congenital cataract, traumatic cataract, complicated cataract.
b) Patients operated for cataract (pseudophakia, surgical aphakia).
c) Patients with pre-existing ocular diseases like glaucoma, uveitis, corneal opacity.
d) Patients with history of diabetes mellitus, hypertension, cardiac diseases, hepatic disorders or renal disorders.
e) Patients with a history of drug intake such as statins, steroids and chemotherapy.
f) Patients with a history of smoking and alcohol consumption.
g) Those who were not willing to take part in this study.

Collection Of Blood Sample For The Study:
Under aseptic conditions, 6 ml of blood was drawn from the antecubital vein using a sterile needle and syringe. The blood was then transferred into pre-labelled clot activator tubes and allowed to clot at room temperature. Serum was separated by centrifuging the samples at 3000 rpm for 3–5 minutes. All samples were properly labelled and coded. Tests were performed immediately whenever possible; if delayed, serum aliquots were stored at 2–8°C until analysis.

Methods:
a) Estimation of Serum Sodium (Na^+), Chloride (Cl^-) and Potassium (K^+) by ISE based Easylyte Electrolyte Autoanalyzer.
b) Estimation of Fasting Plasma Glucose (FPG) by Glucose Oxidase-Peroxidase (GOD-POD) method in XL-640 Full Autoanalyzer.
c) Estimation of Glycated haemoglobin (HbA1c) by Biorad D10 HPLC machine.

Statistical Analysis:
Data entry and analysis were conducted using SPSS version 29.0 on a Windows PC. Categorical data were presented through text, tables, and charts. The student's t-test was employed to assess the significance of difference between two means. Pearson's correlation analysis for testing the significance of association between two or more risk factors was used & p-value of less than 0.05 was considered statistically significant.

RESULTS:

Table 1: Comparison Of Biochemical Parameters In Senile Cataract patients versus Controls

Biochemical Parameters	Senile Cataract Patients (n=100)	Controls (n=100)	P value
Serum Sodium (Na^+) [mEq/l]	146.24 ± 3.14	139.76 ± 4.24	<0.0001**
Serum Chloride (Cl^-) [mEq/l]	109.42 ± 4.16	99.14 ± 3.92	<0.0001**
Serum Potassium (K^+) [mEq/l]	4.2 ± 0.62	4.4 ± 0.56	>0.05
Fasting Plasma Glucose (FPG) [mg/dl]	114.26 ± 24.38	88.14 ± 14.34	<0.0001**
HbA1c (%)	7.1 ± 1.2	5.6 ± 0.7	<0.0001**

****Highly Significant**

Table 2: Pearson Correlation of HbA1c With Serum Electrolytes In Senile Cataract Patients

	Variable	'r' value	'p' value
Glycated Haemoglobin (HbA1c)	Serum Na^+	0.580	<0.001**
	Serum Cl^-	0.638	<0.001**
	Serum K^+	-0.129	0.07

****Highly Significant**

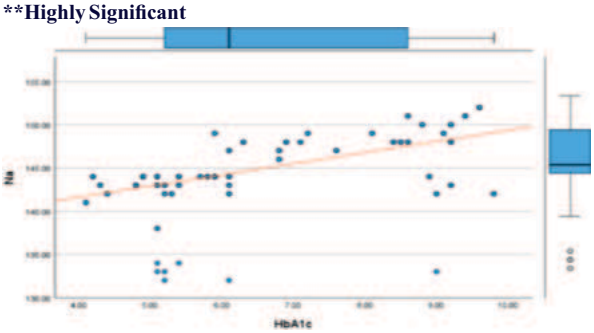

Fig 1: Correlation of HbA1c with S. Na^+

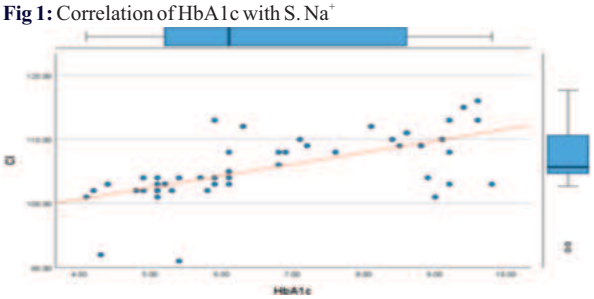

Fig 2: Correlation of HbA1c with S. Cl^-

DISCUSSION:
Senile cataract is a major public health concern that can lead to permanent vision loss if not identified and treated in time. Ongoing research continues to investigate various modifiable and non-modifiable risk factors associated with its development. This study aims to examine serum electrolyte levels and glycemic status as potential biochemical risk factors for senile cataract in a small cohort of Indian patients. Gaining insight into these factors may help in slowing the lens ageing process and enhancing both the prognosis and management of senile cataracts.

Our study revealed that there is statistically significant increase in serum sodium and chloride levels in senile cataract patients compared to controls, however there is no statistically significant difference in serum potassium levels between cases and controls (Table 1). These findings are consistent with a cross-sectional comparative study conducted by Sajla K et al.[6], which reported significantly elevated serum sodium and chloride levels in the cataract group compared to the control group (both with P = 0.000), while serum potassium levels showed no significant difference (P = 0.476). Similar observations were made in studies by Adiga U et al.[7], Jadav PM et al.[8], Sahare H et al.[9], Rajakrishnan PD et al.[10], all of which noted a statistically significant increase in serum sodium and chloride levels among patients with senile cataract, without any notable variation in serum potassium levels.

We also observed statistically significant increase in fasting plasma glucose and glycated haemoglobin (HbA1c) levels in senile cataract patients compared to controls (Table 1). These findings are in agreement with a nested case-control study by Becker C et al.[11], which identified a statistically significant link between elevated HbA1c levels and an increased risk of developing senile cataracts. Similarly, a descriptive study by Nurpalah R et al[12]. at the National Eye Centre Cicendo PMN Hospital in Indonesia reported that 50% of senile cataract patients had elevated fasting plasma glucose levels. Our results are also in line with the findings of studies conducted by Pek A et al.[13] and Harahap J et al.[14]

Aqueous humor derived from serum nourishes the lens, and its electrolyte composition is influenced by serum electrolyte levels. The lens normally maintains high potassium and low sodium levels through the Na^+-K^+ ATPase pump and capsule permeability. With aging, changes in membrane fluidity reduce ion permeability, making the lens more reliant on this pump, whose activity also declines with age. Elevated serum sodium can raise sodium in the aqueous humor, disrupt lens electrolyte balance, and potentially lead to senile cataract formation.[4,6]

Chloride is vital for maintaining ion balance and hydration in the lens via the Na^+-K^+-$2Cl^-$ cotransporter. Aging increases lens membrane permeability, impairing this transport. Elevated serum chloride can lead to excess chloride in the lens, disrupting osmotic balance and causing cloudiness, which contributes to development of senile cataract.[6]

High blood glucose activates the polyol pathway in the lens, converting glucose to sorbitol and then to fructose. Due to low sorbitol dehydrogenase activity in the lens, sorbitol accumulates, causing osmotic stress and oxidative damage. This damages lens fibers and contributes to development of senile cataract.[15]

The study found a statistically significant positive correlation between HbA1c and both serum sodium and chloride levels. However, the negative correlation between HbA1c and serum potassium was not statistically significant. (Table-3; Fig-1,2)

The elevated serum sodium (hypernatremia) and chloride (hyperchloremia) levels observed in our study population may be due to several factors. One likely cause is excessive consumption of table salt, as indicated by previous research.[16,17] Another contributing factor could be osmotic diuresis, commonly associated with hyperglycemia. In this condition, elevated blood glucose levels prompt increased urine output as the body attempts to eliminate excess glucose. This increased urination leads to fluid and electrolyte loss, which can concentrate sodium and chloride levels in the serum.[18,19]

CONCLUSION:
This hospital-based cross-sectional study evaluated serum electrolytes and glycemic status in 100 senile cataract patients over 50 years old

and 100 age-matched healthy individuals. The findings revealed a high prevalence of hypernatremia, hyperchloremia and poor glycemic control. Poor glycemic control likely contributes to oxidative stress, elevating serum electrolytes, and cataract development through the polyol pathway. Elevated sodium and chloride levels may impair lens function, while excessive salt intake and osmotic diuresis could further worsen these imbalances. The study highlights the value of monitoring serum sodium, chloride, fasting plasma glucose and HbA1c in assessing senile cataract risk and underscores the need for dietary modifications and effective glycemic control to delay cataract progression.

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Conflict Of Interest: None

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