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Original Research Article

Comparison of serum sodium and potassium levels in patients with cataract and individuals without cataract in a tertiary care center in North Kerala: a cross-sectional study

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ABSTRACT

Background: Cataract remains a leading cause of treatable blindness worldwide, accounting for moderate to severe vision impairment or blindness in approximately 94 million people globally. The study aimed to compare serum sodium and potassium levels between individuals with and without cataract and to assess whether these electrolyte levels vary among the different types of senile cataract classified according to the LOCS III (lens opacities classification system III) classification.
Methods: A cross-sectional observational study was conducted on 200 patients aged 50-60 years attending the ophthalmology OPD at a tertiary care center from 2022 to 2024. Cataracts were graded after dilated fundus examination. Serum sodium and potassium levels were measured using ion-selective electrode technology (Beckman Coulter AU-5800). Statistical analysis included descriptive tools and Student's t-test to assess differences between means.
Results: Mean serum sodium was higher in the cataract group (139.3 mEq/l) compared to the non-cataract group (136.6 mEq/l). Serum potassium was also slightly higher in the cataract group, though not statistically significant. Among cataract types, posterior subcapsular cataract showed the highest serum sodium levels. Nuclear sclerosis cases had marginally higher potassium levels than other types, but the difference was not significant.
Conclusions: Serum sodium levels were significantly higher in patients with cataract, though still within the normal range. This suggests that dietary sodium restriction might help delay cataract development.

Keywords: Senile cataract, Serum potassium, Serum sodium

INTRODUCTION

Cataract remains one of the leading causes of blindness among adults aged 50 years and above, accounting for approximately 15.2 million cases worldwide, as reported by the World Health Assembly (WHA) in Towards Universal Eye Health: A Global Action Plan 2014-2019.[1] Although the precise mechanism of cataractogenesis is not fully understood, several risk factors have been implicated, including aging, radiation exposure, smoking, prolonged steroid use, and metabolic disturbances.

The human lens maintains a characteristic electrolyte composition, with low intracellular sodium and high potassium concentrations. This ionic balance is regulated by the Na^+/K^+-ATPase pump, an essential membrane-bound enzyme responsible for active ion transport.[2] In patients with senile cataract, diminished Na^+/K^+-ATPase activity has been observed, leading to increased intracellular sodium levels, which may contribute to lens opacity and cataract formation. Therefore, a high-sodium diet may elevate the risk of cataract development, while dietary salt restriction could help delay or reduce cataractogenesis.

The present study aimed to evaluate whether significant differences exist in serum sodium and potassium levels between patients with senile cataract and age-matched individuals without cataract.

METHODS

After obtaining approval from the institutional ethics committee (IEC No.43/2022/GMCK), 100 patients with cataract and 100 individuals without cataract who presented to the Ophthalmology OPD in Government medical college Kannur were included in the study. Informed consent was obtained from all participants. This observational cross-sectional study was conducted from 2022 to 2024. Consecutive subjects were enrolled after confirming eligibility.

Inclusion criteria

Participants aged between 50 and 60 years, irrespective of sex, who provided informed consent and were willing to undergo fundoscopy were included in the study.

Exclusion criteria

Individuals with systemic conditions such as hypertension, diabetes mellitus, renal disease, senile dementia, or other chronic diseases were excluded from the study. Patients with secondary cataracts, including post-inflammatory, steroid-induced, or traumatic cataracts, were also excluded. Individuals with a history of medication use known to influence serum sodium or potassium levels, such as diuretics, as well as those with a history of using topical anti-glaucoma medications, were excluded. Based on the eligibility criteria, the participants were divided into two groups: group I consisted of patients diagnosed with senile cataract, while group II comprised age-matched individuals without cataract.

All patients included in the study underwent a comprehensive clinical evaluation. A detailed history was obtained, documenting the primary reason for the visit and any prior use of spectacles or contact lenses. Following history taking, visual function was assessed, including distant visual acuity using the Snellen chart, near vision using standardized near vision charts, and colour vision using the Ishihara chart.

A thorough ophthalmological examination was conducted, including slit-lamp biomicroscopy. Pupillary dilation was achieved using a combination of Tropicamide and Phenylephrine eye drops, administered three times at 20-minute intervals. Subsequently, a fundus examination was performed. The severity and type of cataract were classified according to the lens opacities classification system III (LOCS III).

For biochemical analysis, 2 ml of venous blood was collected from each subject under strict aseptic conditions using standard venipuncture technique. Serum sodium and potassium levels were measured using an ion-selective electrode method on a Beckman Coulter AU-5800 electrolyte analyser. All samples were processed within two hours of collection to ensure accuracy.

Biochemical analyses were conducted consistently in the same biochemistry laboratory using uniform procedures throughout the duration of the study. Collected data were systematically tabulated and subjected to statistical analysis for result interpretation.

The study was conducted in accordance with the principles of the Declaration of Helsinki.

Statistical tools used

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics software, version 24. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize the data. Inferential statistical analysis was performed using the student's t-test to compare differences between two means. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 200 patients were included in the study and divided into two groups: group I- patients diagnosed with cataract, and group II- individuals without cataract (control group). Serum sodium and potassium levels were analyzed and compared between the two groups.

Baseline parameters and group comparison

In the present study, the mean serum sodium level was slightly higher in group I (patients with cataract) than in group II (controls), with mean values of 139.3 mEq/l and 136.6 mEq/l, respectively. This difference was statistically significant ($p<0.05$).

The mean serum potassium level was also marginally higher in group I compared to group II; however, the difference was not statistically significant.

Comparison among types of cataract

Preliminary observations suggest that patients with posterior subcapsular cataract may exhibit a slightly higher mean serum sodium level (140 mEq/l) compared to those with nuclear sclerosis and mixed-type cataracts. Similarly, serum potassium levels were marginally higher in patients with nuclear sclerosis (4.1 mEq/l) compared to those with posterior subcapsular or mixed cataracts, but this difference was also not statistically significant.

Age distribution

Preliminary observations from the present study are limited to individuals aged 50-60 years, with most cataract patients (75%) clustered in the 55-60-year group and

controls predominantly (52%) in the 50-54-year group. The mean age was also higher in group I (56.7±3.9 years) compared to group II (54.3±4.1 years) (Table 1, p<0.01). In older populations (>70 years), age-related decline in Na^+/K^+-ATPase pump activity may be more pronounced, potentially leading to greater disturbances in electrolyte homeostasis, such as increased intracellular sodium accumulation and potassium depletion. Therefore, the electrolyte alterations observed in this study may be accentuated in older cohorts, possibly contributing to increased severity or progression of cataract changes.

Table 1: Comparison of age based on group.

Age	Group I		Group II	
	Count	Percent	Count	Percent
50-54	25	25.0	52	52.0
55-60	75	75.0	48	48.0
Mean±SD	56.7±3.9		54.3±4.1	

t=4.23, p<0.01.

Sex distribution

Sex distribution was comparable between groups, with males comprising 54% of the cataract group and 53% of controls. This difference was not statistically significant (χ^2=0.02, p=0.887), indicating no sex-related bias.

Types of cataracts

The distribution of different cataract types among patients is illustrated in Figure 1.

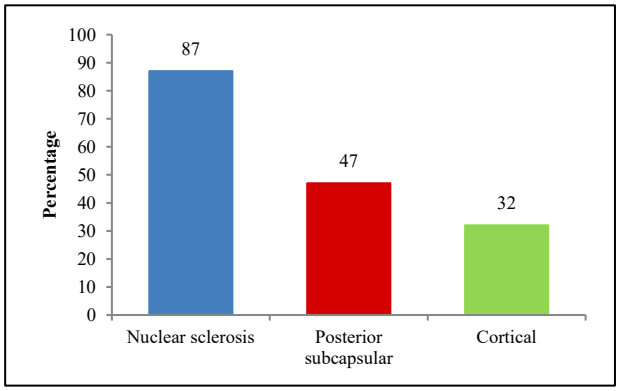

Figure 1: Distribution of cataract types among patients.

Serum sodium levels

Cataract patients (group I) exhibited higher mean serum sodium levels (139.3±1.4 mEq/l) than individuals without cataract (group II) (136.6±1.4 mEq/l) (Table 2). The median sodium level was also elevated in the cataract group [139 mEq/l (IQR: 138-140)] compared to controls [136 mEq/l (IQR: 136-137)]. This difference was statistically significant (t=13.54, p<0.01) (Table 3).

Table 2: Descriptive statistics regarding sodium in group I and group II.

	Group I	Group II
Mean±SD	139.3±1.4	136.6±1.4
Median (IQR)	139 (138-140)	136 (136-137)
Minimum	136	134
Maximum	143	142

Table 3: Comparison of sodium in group I and group II.

Group	Mean	SD	N	t	P
Group I	139.3	1.4	100	13.54	p<0.01
Group II	136.6	1.4	100		

Serum potassium levels

The mean serum potassium level was slightly higher in cataract patients (4.1±0.3 mEq/l) than in controls (4.0±0.4 mEq/l) (Table 4). Median values were identical (4.0 mEq/l) in both groups, with overlapping interquartile ranges. The difference was not statistically significant (t=1.39, p=0.167) (Table 5).

Table 4: Descriptive statistics regarding potassium in group I and group II.

	Group I	Group II
Mean±SD	4.1±0.3	4±0.4
Median (IQR)	4 (3.93-4.18)	4 (3.8-4.2)
Minimum	3.4	3.3
Maximum	5.0	5.0

Table 5: Comparison of potassium in group I and group II.

Group	Mean	SD	N	t	p
Group I	4.11	0.33	100	1.39	0.167
Group II	4.04	0.37	100		

Serum sodium and potassium by cataract type

Preliminary observations indicate that patients with posterior subcapsular cataract tended to have relatively higher serum sodium concentrations compared to those with nuclear sclerosis and mixed cataracts (Table 6).

Table 6: Comparison of sodium in patients with cataract (group I) based on type of cataract.

Group	Mean	SD	N	F	P
Nuclear sclerosis	139.5	1.7	31	1.59	0.21
Posterior subcapsular	140.0	1.3	6		
Mixed	139.1	1.2	62		

Serum potassium levels were highest among patients with nuclear sclerosis (4.12±0.32 mEq/l), followed by mixed (4.11±0.34 mEq/l) and posterior subcapsular types (4.05±0.29 mEq/l), but these variations were not statistically significant (F=0.106, p=0.899) (Table 7).

Table 7: Comparison of potassium in patients with cataract (group I) based on type of cataract.

Group	Mean	SD	N	F	P
Nuclear sclerosis	4.12	0.32	31	0.106	0.899
Posterior subcapsular	4.05	0.29	6		
Mixed	4.11	0.34	62		

DISCUSSION

In the present study, serum sodium levels were found to be slightly higher in group I compared to group II, with mean values of 139.3 mEq/l and 136.6 mEq/l, respectively. This difference was statistically significant (p<0.01). Serum potassium levels were also marginally higher in the cataract group (4.11±0.33 mEq/l) compared to the control group (4.04±0.37 mEq/l), but this difference was not statistically significant (p=0.167).

Preliminary observations indicate that within the cataract subtypes, patients with posterior subcapsular cataract exhibited slightly higher mean serum sodium levels (140 mEq/l) compared to those with nuclear sclerosis and mixed cataracts. Serum potassium levels were marginally higher in patients with nuclear sclerosis (4.1 mEq/l) than in those with posterior subcapsular and mixed cataracts, though the difference also lacked statistical significance.

The study by Sahare et al compared serum electrolyte levels between senile cataract patients and healthy controls. It found that mean serum sodium levels were significantly higher in the cataract group (135.5 mEq/l) compared to controls (133.1 mEq/l), along with relatively lower potassium levels. The findings suggest that electrolyte imbalance, particularly elevated sodium, may contribute to cataract formation by disrupting lens osmotic balance.[3]

The study by Durairaj and Ponnugandhi compared serum electrolytes in diabetic and non-diabetic senile cataract patients. It found that diabetic patients had significantly higher serum sodium levels (144.16±2.25 mEq/l) compared to non-diabetic controls (140.26±3.60 mEq/l; p<0.001), along with greater electrolyte imbalance overall. These findings suggest that diabetes-related metabolic disturbances may exacerbate cataract formation.[4]

Bansal et al analyzed 348 eyes from 336 cataract patients to examine the relationship between serum and aqueous humor electrolytes. The mean patient age was 62.35±10.08 years, with a nearly equal gender distribution. Cataract types included mixed (195), mature (51), and nuclear sclerosis (74). The mean aqueous humor levels were 146.48±6.59 mEq/l for sodium, 4.15±0.305 mEq/l for potassium, and 118.3±5.49 mEq/l for chloride. Significant positive correlations were observed between serum and aqueous humor levels for sodium (r=0.155, p=0.004) and potassium (r=0.44, p<0.05), suggesting that systemic electrolyte levels partially reflect intraocular electrolyte status, which may influence cataract formation.[5]

Sofi et al demonstrated significantly higher serum sodium levels in senile cataract patients (139.60±5.23 mEq/l) than in controls (137.15±2.93 mEq/l, p<0.0001), with no significant difference in potassium levels (p=0.60). These findings are consistent with our results.[6]

These findings also align with those of Mathur and Pai, who reported significantly elevated serum sodium levels in cataract patients (135.1 mEq/l) compared to controls (133.1 mEq/l, p<0.001), with no significant differences in potassium levels. Their subgroup analysis revealed higher sodium levels in patients with nuclear and mixed cataracts, supporting the hypothesis that increased serum sodium may contribute to cataractogenesis.[7]

Similarly, Mirsamadi et al found significantly elevated serum sodium levels in cataract patients (144.96±6.04 mEq/l) compared to controls (140.88±2.27 mEq/l, p<0.0001), while potassium levels showed no significant variation between groups. This parallels our results, despite differences in sample age range- our study focused on individuals aged 50-60 years, whereas Mirsamadi et al included participants aged 44-85 years.[8]

Smitha et al also reported a statistically significant increase in plasma sodium levels in cataract patients (145.06±5.84 mEq/l) compared to controls (141.18±2.67 mEq/l, p<0.0001), with no significant difference in potassium levels (p=0.002), which supports the current findings.[9]

In a cross-sectional study by Soni et al., serum sodium levels were significantly higher in cataract patients (145.81±1.15 mEq/l) compared to controls (143.78±2.39 mEq/l). Although serum potassium levels were slightly elevated (4.33±0.25 mEq/l versus 4.27±0.31 mEq/l), the difference was not statistically significant, again reflecting the trends observed in our study.[10]

Khan et al examined serum electrolytes in cataract patients and age-matched controls, reporting significantly higher serum sodium in the cataract group (145.39±3.04 mEq/l) compared to controls (139.63±13.91 mEq/l, p<0.01). Interestingly, their subgroup analysis showed significantly higher sodium levels in nuclear, cortical, and mixed cataracts but not in posterior subcapsular cataract (p=0.273). In contrast, our study showed slightly elevated sodium levels in posterior subcapsular cataract, though the difference was not statistically significant.[11]

Collectively, the evidence from this study and previous literature supports the hypothesis that elevated serum

sodium levels may be associated with cataract formation, particularly in senile cataract patients. However, serum potassium levels appear not to differ significantly, suggesting a limited role in cataractogenesis.

The study population was limited to patients attending a single ophthalmology outpatient department at Government Medical College, Kannur, which may limit the generalizability of the findings to other populations and healthcare settings. The prospective observational design allows for the assessment of associations but does not establish a causal relationship; therefore, longitudinal studies or randomized controlled trials are required to further evaluate causality. Additionally, only a single blood sample was analyzed for serum sodium and potassium levels, which may not reflect variations in electrolyte levels over time. Furthermore, the study was restricted to participants in the 50-60-year age group, limiting the applicability of the findings to individuals outside this age range.

CONCLUSION

Our study found significantly higher serum sodium levels in cataract patients (139.3 versus 136.6 mEq/l, $p<0.05$), while potassium levels showed no significant difference (4.11 versus 4.01 mEq/l). Posterior subcapsular cataracts had higher sodium (140 mEq/l) and nuclear sclerosis showed slightly higher potassium (4.12 mEq/l), both non-significant. These results suggest elevated serum sodium may contribute to cataract formation, and dietary sodium reduction could help delay its onset. Hence, further longitudinal studies are required to evaluate the impact of dietary interventions.

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