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Original Research Article

COMPARATIVE STUDY OF SERUM ELECTROLYTE PROFILES IN SENILE CATARACT PATIENTS WITH AND WITHOUT DIABETES MELLITUS

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ABSTRACT

Background: Senile cataracts, a common cause of visual impairment, are accelerated by diabetes, and electrolyte imbalance may contribute to lens opacification, although data on their association in India remain limited. This study aimed to examine the correlation between serum electrolyte levels and senile cataracts in individuals with and without diabetes. **Materials and Methods:** This hospital-based, cross-sectional included 130 patients aged over 40 years with senile cataracts, divided into diabetic (n = 65) and non-diabetic (n = 65) groups. Ophthalmological evaluation and laboratory tests for fasting blood sugar, HbA1C, and serum electrolyte levels were performed. **Result:** The mean age was 61.8 ± 7.6 years in diabetics and 63.1 ± 6.9 years in non-diabetics (p = 0.312). Diabetic patients had higher fasting blood sugar (159.6 ± 31.9 vs. 93.9 ± 15.2 mg/dL; p < 0.001) and HbA1C (7.4 ± 0.7% vs. 5.3 ± 0.4%; p < 0.001). Serum sodium (147.7 ± 1.8 vs. 144.1 ± 2 mEq/L; p < 0.001), potassium (4.31 ± 0.28 vs. 4.04 ± 0.32 mEq/L; p = 0.012), and chloride (102.1 ± 1.4 vs. 100.1 ± 1.3 mEq/L; p < 0.001) were higher in diabetics. Cataract types were similar. Sodium (r = 0.46; p = 0.001) and chloride (r = 0.39; p = 0.004) correlated positively with HbA1C; the potassium correlation was weak and non-significant (r = 0.21; p = 0.088). **Conclusion:** Diabetic patients with senile cataracts have higher serum electrolytes, particularly sodium and chloride, which correlate with glycaemic control. Monitoring blood sugar and electrolytes may help manage cataract risk.

INTRODUCTION

A cataract is the loss of clearness of the natural lens of the eye, causing visual impairment such as blurred vision, poor contrast, or sometimes double vision. It is mainly treated by surgical removal of the dense lens. Worldwide, cataract is a main cause of visual disability, affecting about 94 million people aged 50 years and above as of 2020. The number is expected to increase with population ageing.[1] The senile or age-related type is the most frequent form and accounts for nearly half of all cases of visual blindness. This imposes a significant health and economic burden, particularly on developing countries. Certain metabolic conditions and lifestyle habits, including smoking, alcohol use, and frequent coffee intake, have been linked to a higher occurrence of senile cataract.[2] In India, cataract is responsible for about 66.2% of total blindness and 71.2% of visual loss among people aged > 50 years, as reported by the National Programme for Control of Blindness and Visual Impairment (2015–2019).[3]

Diabetes mellitus accelerates cataract development and causes an earlier onset. Chronic hyperglycaemia leads to sorbitol accumulation in the lens, increased oxidative stress, and non-enzymatic glycation of lens proteins, resulting in faster lens opacification.[4,5] Diabetic cataracts are often posterior subcapsular or cortical, progress more rapidly, and are influenced by glycaemic control, with poor control increasing risk and tight control delaying onset.[3,5]

The lens maintains transparency through a precise balance between water and ions. Sodium and potassium gradients, regulated by Na^+/K^+-ATPase pumps, ensure osmotic stability.[6] Disruption of these electrolytes can cause osmotic imbalance, fibre swelling, protein aggregation, and loss of clarity, contributing to cataract formation. Studies have shown altered serum electrolytes in cataract patients, but findings vary with population, diet, and methods, indicating the need for further research on their role in cataract formation.[7-9]

Data from India on the link between serum electrolytes and cataracts are limited. Regional

factors such as climate, diet, and lifestyle may influence electrolyte balance and lens health. This study aimed to assess the correlation between serum electrolytes and senile cataracts and to compare these findings in diabetic and non-diabetic individuals from India.

MATERIALS AND METHODS

This was a hospital-based, observational, cross-sectional study involving 130 patients with senile cataracts scheduled for surgery in the Ophthalmology OPD at ESIC Model Hospital, India, from April 2023 to July 2023. Approval was obtained from the institutional ethical committee, and informed consent was obtained from all patients.

Inclusion Criteria

Patients aged over 40 years diagnosed with senile cataracts with type 2 diabetes mellitus, and age and sex-matched non-diabetic patients with cataracts were included.

Exclusion Criteria

Patients with complicated cataract, liver, kidney, thyroid, or other systemic disorders, infections, a history of trauma, use of oral steroids, and alcoholics or smokers were excluded.

Methods

Group A included patients with type 2 diabetes mellitus (n = 65), and Group B included non-diabetic patients (n = 65). All patients were diagnosed with senile cataracts. Each patients underwent a detailed eye examination. Medical, ocular, and family histories were recorded, and visual acuity and refraction were assessed. The lens was examined using a slit-lamp, and cataract grading was done according to the Lens Opacities Classification System III (LOCS III). Fundus examination with a 90-diopter lens was performed to evaluate the posterior segment.

Blood investigations were done for all patients. Tests included serum electrolytes (sodium, potassium, and chloride), fasting and post-prandial blood glucose, HbA1c, serum creatinine, and serum urea. All clinical and laboratory tests were carried out following standard procedures.

Statistical Analysis

Data were analysed using IBM SPSS Statistics, v27. Continuous variables were presented as mean ± standard deviation (SD), and categorical in numbers and percentages. The relationship was assessed using Pearson's correlation test. A p-value of ≤ 0.05 was taken as statistically significant.

RESULTS

The mean age of diabetic patients was 61.8 ± 7.6 years, while non-diabetic patients had a mean age of 63.1 ± 6.9 years (p = 0.312). Among the diabetic patients, 29 were male (44.6%) and 36 were female (55.4%), compared with 31 males (47.7%) and 34 females (52.3%) in the non-diabetic group (p = 0.726). The mean duration of diabetes in the diabetic group was 8.4 ± 3.1 years. The mean BMI was 25.6 ± 3.8 kg/m² in diabetic patients and 24.9 ± 3.5 kg/m² in non-diabetic patients (p = 0.248). [Table 1]

Table 1: Demographic and clinical characteristics

Parameter	Diabetic cataract (n = 65)	Non-diabetic cataract (n = 65)	p-value
Mean age (years) ± SD	61.8 ± 7.6	63.1 ± 6.9	0.312
Sex (Male/female)	29 / 36	31 / 34	0.726
Duration of diabetes (years)	8.4 ± 3.1	—	—
Mean BMI (kg/m²) ± SD	25.6 ± 3.8	24.9 ± 3.5	0.248

Diabetic patients had significantly higher fasting blood sugar (159.6 ± 31.9 mg/dL vs. 93.9 ± 15.2 mg/dL; p < 0.001) and HbA1C (7.4 ± 0.7% vs. 5.3 ± 0.4%; p < 0.001) compared to non-diabetic patients. Serum sodium (147.7 ± 1.8 vs. 144.1 ± 2 mEq/L; p < 0.001), potassium (4.31 ± 0.28 vs. 4.04 ± 0.32 mEq/L; p = 0.012), and chloride (102.1 ± 1.4 vs. 100.1 ± 1.3 mEq/L; p < 0.001) were also significantly higher in diabetic patients. There were no significant differences in serum urea (31.5 ± 7.8 vs. 28.9 ± 6.9 mg/dL; p = 0.056), serum creatinine (0.96 ± 0.18 vs. 0.91 ± 0.14 mg/dL; p = 0.141), blood pressure (128/82 ± 10/6 vs. 126/80 ± 8/5 mmHg; p = 0.289), or cataract types, including nuclear sclerosis (36, 55.4% vs. 32, 49.2%); p = 0.452), cortical cataract (18, 27.7% vs. 22, 33.8%); p = 0.412), and posterior subcapsular cataract (11, 16.9% vs. 11, 16.9%). [Table 2]

Table 2: Clinical, biochemical, and cataract type comparison between patients

Variable		Diabetic cataract (Mean ± SD)/ N (%)	Non-diabetic cataract (Mean ± SD)/N (%)	p-value
Clinical parameter	Fasting blood sugar (mg/dL)	159.6 ± 31.9	93.9 ± 15.2	<0.001
	HbA1C (%)	7.4 ± 0.7	5.3 ± 0.4	<0.001
	Serum urea (mg/dL)	31.5 ± 7.8	28.9 ± 6.9	0.056
	Serum creatinine (mg/dL)	0.96 ± 0.18	0.91 ± 0.14	0.141
	Blood pressure (mmHg)	128/82 ± 10/6	126/80 ± 8/5	0.289
Serum electrolyte	Sodium (mEq/L)	147.7 ± 1.8	144.1 ± 2.0	<0.001
	Potassium (mEq/L)	4.31 ± 0.28	4.04 ± 0.32	0.012
	Chloride (mEq/L)	102.1 ± 1.4	100.1 ± 1.3	<0.001
Type of cataract	Nuclear sclerosis	36 (55.4%)	32 (49.2%)	0.452
	Cortical cataract	18 (27.7%)	22 (33.8%)	0.412

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	Posterior subcapsular cataract	11 (16.9%)	11 (16.9%)	—

Correlation analysis showed a significant positive relationship between serum sodium and HbA1C levels (r = 0.46; p = 0.001) and between serum chloride and HbA1C levels (r = 0.39; p = 0.004). Serum potassium levels showed a weak positive correlation with HbA1C (r = 0.21), with no significant difference (p = 0.088). [Table 3]

Table 3: Correlation between serum electrolytes and HbA1c in cataract patients

Parameter	Pearson's correlation	p-value
Serum sodium vs HbA1C	0.46	0.001
Serum potassium vs HbA1C	0.21	0.088
Serum chloride vs HbA1C	0.39	0.004

DISCUSSION

This study examined the relationship between serum electrolyte levels and senile cataracts in patients with and without diabetes in India. Patients with and without diabetes showed similar age and sex distributions. Similarly, Sowmya and Vallabha study of 58 eyes, the mean age was 56.5 ± 7.4 years in diabetics and 59.6 ± 5.2 years in non-diabetics.[10] Thus, age and sex were similar in both groups, suggesting comparability; the study could expand the sample size for stronger statistical validity.

Our study showed that diabetic patients had higher blood sugar and HbA1C levels, along with increased serum electrolytes, than non-diabetic patients. Similarly, Durairaj et al. diabetic senile cataract patients showed significantly higher fasting (175.84 ± 45.45 mg/dL) and postprandial blood sugar levels (279.82 ± 82.04 mg/dL) compared to non-diabetic controls (92.16 ± 7.4 mg/dL and 119.68 ± 11.61 mg/dL, respectively; $p < 0.001$). HbA1c levels were also elevated in cases (8.108 ± 48%) compared to controls (5.29 ± 29% %, $p < 0.001$). Serum sodium levels were significantly higher in diabetic patients (144.16 ± 2.25 mEq/L) than in controls (140.26 ± 3.60 mEq/L; $p < 0.001$), while serum potassium showed no significant difference between groups (4.43 ± 0.38 vs. 4.41 ± 0.29 mEq/L; $p > 0.05$).[11]

Similarly, Harahap et al., show that diabetic cataract patients showed significantly higher blood glucose levels (195.58 ± 63.9 mg/dL) than non-diabetic cataract patients (109.7 ± 26.4 mg/dL; $p < 0.001$).[12] Inchara et al. found that diabetic cataract patients showed higher serum sodium (146.1 ± 2.5 mEq/L), potassium (4.4 ± 0.08 mEq/L), and chloride (95.8 ± 0.7 mEq/L) than non-diabetics (143.4 ± 2.85, 4.2 ± 0.04, 90.6 ± 0.6 mEq/L; $p < 0.05$).[13] Therefore, diabetic patients had higher blood sugar, HbA1C, and electrolytes, highlighting the need for careful monitoring to manage cataract-related complications.

In this study, the distribution of cataract types (nuclear sclerosis, cortical cataracts, and posterior subcapsular cataracts) was not significantly different between patients with and without diabetes. Memon et al., in a large study, reported that nuclear sclerosis was the most common cataract type in 46.6% of diabetic patients, while posterior subcapsular cataract predominated in 32.3% of nondiabetic patients.[14] In this case, cataract types were similar, with nuclear sclerosis in diabetics and posterior subcapsular in non-diabetics, highlighting subtype consideration in risk assessment.

In our study, serum sodium and chloride levels were positively associated with HbA1C, while serum potassium showed only a weak, non-significant relationship with glycaemic levels. Similarly, Kolhe Nema et al. found that in diabetic patients with senile cataracts, serum sodium showed moderate positive correlations with good (r=.452, p=0.011) and fair (r=.681, p≤0.01) glycaemic control, while potassium correlations were weak/negative. In non-diabetic patients, correlations were not significant.[15] Kaliaperumal et al. higher HbA1c levels were associated with increased serum sodium ($r = 0.223$, $p < 0.001$) and potassium ($r = 0.166$, $p = 0.026$) concentrations in type 2 diabetes patients.[16] This shows that elevated serum sodium is linked to poor glycaemic control, whereas potassium shows weak associations, emphasising regular electrolyte monitoring in diabetic patients.

The current study on diabetic cataract patients showed higher blood sugar, HbA1C, and serum sodium levels, with cataract types similar to non-diabetics, highlighting the need for regular monitoring of glycaemic status and electrolytes.

Limitations

This hospital-based, cross-sectional study could not establish causal relationships between serum electrolyte levels and cataracts. The sample was small and from a single centre, limiting the generalisability of the results. Factors such as diet, medications, and long-term glycaemic variability were not fully controlled, and the effects of electrolyte disturbances on cataract severity or progression were not analysed.

CONCLUSION

Patients with diabetic cataract showed significantly higher serum sodium, potassium, and chloride levels than non-diabetic cataract patients. Serum sodium and chloride demonstrated a positive correlation with HbA1c, while potassium showed a weak and statistically insignificant association. The distribution of cataract types, including nuclear, cortical, and posterior subcapsular forms, was comparable between the two groups. These findings indicate that electrolyte disturbances in diabetic patients are linked to metabolic changes rather than to the structural type of cataract. Monitoring serum

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electrolytes together with glycaemic status may aid in the clinical assessment of diabetic individuals presenting with cataract.

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