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RESEARCH ARTICLE

Serum electrolytes in patients with senile cataract

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ABSTRACT

Background: Senile cataract, the world's leading cause of treatable blindness, is an age-related, vision-impairing disease characterized by gradual progressive thickening of the lens. Disturbance in the concentration of serum electrolytes plays a very important role in the etiopathogenesis of senile cataract. **Aims and Objectives:** This study aims to study and compare the level of serum sodium, potassium, and chloride in patients with senile cataract and in controls. **Materials and Methods:** A cross-sectional comparative study was conducted in 100 subjects aged between 50 and 80 years, which include 50 senile cataract patients and 50 healthy controls. The Statistical Package for the Social Sciences version 18 was used for statistical analysis. **Results:** The mean values of serum sodium and chloride were significantly elevated in senile cataract patients when compared to controls. There was no significant difference in mean potassium level between the two groups. **Conclusion:** Disturbances in the concentration of serum electrolytes can alter their concentration in aqueous humor, which might exceed the capacity of pumps and channels present in the lens membrane, resulting in volume overload and lens opacities. Therefore, the level of serum sodium and chloride can be used as markers of senile cataract formation. Dietary salt restriction can help to delay the progress of cataract formation.

KEY WORDS: Chloride; Potassium; Senile Cataract; Serum Electrolytes; Sodium

INTRODUCTION

Cataract is any opacity of lens or its capsule, either developmental or acquired.[1] Cataract can be classified etiologically into congenital and acquired types, whereas senile or age-related cataract is the most common type. It is usually seen in elderly persons above 50 years of age. Senile cataract, a physiological disorder of the eye occurring in 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] As per the World Health Organization (WHO), the total number of persons with visual impairment worldwide in 2010 was 285 million and cataract is responsible for 51% of world blindness, which represents about 20 million people.[3] In 2014, as per the WHO, about 95% of people are visually impaired due to cataract.[4]

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The causative factors for senile cataract are yet to be defined and no single adequate molecular explanation for this is currently available. Harding proposed a variety of factors which were implicated in the pathogenesis of cataract: A low antioxidant defense capacity, high lipid peroxidation, an increased non-enzymatic glycosylation, a reduced chaperone function of the alpha-crystallins, and an increased permeability of the lens membrane.[5] The oxidative changes affect the serum electrolytes which equally results in disorder in lens membrane permeability.[6]

Aqueous humor is a clear fluid secreted by the ciliary epithelium from the serum. Lens lies in close apposition with aqueous humor and derives its nutrition from it. The composition of aqueous humor is almost similar to that of plasma except for proteins and ascorbate. Therefore, any electrolyte imbalance in the serum can lead to changes in aqueous humor electrolytes which can affect the lens metabolism, leading to cataract formation.[7]

Normally, lens has high concentration of potassium (114–130 mmol/L) and low concentration of sodium (14–26 mmol/L). These two cations are kept in balance with each other by Na^{+}-K^{+} ATPase pump and permeability of the lens capsule.[8] Alteration in either of these ions may lead to cation imbalance in lens and result in cataract formation. As age increases, there will be an increase in lens capsular permeability and decrease in the activity of the Na^{+}-K^{+} ATPase, which causes increased sodium ions within the lens. High level of serum sodium might make it more difficult for Na^{+}-K^{+} ATPase pump to maintain low level of intracellular sodium required for lens transparency. Therefore, higher levels of serum sodium by itself may contribute to the formation of senile cataract.[8]

Some studies have shown altered serum chloride in senile cataract patients. Chloride plays a very important role in membrane ion transport mechanisms within the lens. The Na-K-2Cl cotransporter in the lens is dependent on cation and anion concentration. Since the permeability of the lens increases with aging, chloride handling by the lens will be affected when there is an increase in serum chloride concentration. Hence, the ability of the lens to maintain hydrated state is lost, which will cause an imbalance in osmotic equilibrium and results in cataract formation.[9]

The present study has been undertaken to evaluate the changes in serum electrolytes, namely, sodium, potassium, and chloride in senile cataract patients. As cataract is one among the treatable causes of blindness, it is justifiable to make an attempt to identify the probable risk factors for the cataractogenesis. Therefore, it is important to know whether altered serum electrolytes level could lead to the development and progression of senile cataract.

MATERIALS AND METHODS

It was a cross-sectional comparative study done in the Department of Ophthalmology, Government Medical College, Kozhikode. The study was done after getting sanction from the Institutional Ethics Committee, Government Medical College, Kozhikode. The study was conducted for 1 year.

Study Population

Fifty patients with senile cataract in the age group of 50–80 years were taken as cases. Fifty age- and sex-matched normal subjects were taken as controls which include hospital staff and patient's bystanders attending Government Medical College, Kozhikode. To ensure their voluntary participation, subjects were briefed about the objectives and methods of the study and an informed written consent was taken before the study. Detailed history was taken as including their history, drug history, and personal history. Relevant clinical examination was done to rule out major diseases. Blood samples were collected for blood investigations.

Inclusion Criteria

One hundred subjects were included in this study. A prior informed consent was obtained from all participants. They were divided into two groups.

- Group I: Fifty senile cataract patients in the age group of 50–80 years, who were admitted for cataract surgery.
- Group II: Fifty age- and sex-matched normal healthy individuals, not suffering from any other illness.

Exclusion Criteria

Patients with complicated cataract; systemic diseases such as diabetes mellitus, hypertension, and acute or chronic renal failure; acute or chronic diarrhea; patients with a history of drug intake such as steroids, antipsychotics, and chemotherapy were excluded from the study.

Estimation of Serum Electrolytes

Electrolytes affect most of the metabolic processes in our body. They serve to maintain osmotic pressure and hydration of various body fluid compartments, proper body pH, and regulation of appropriate heart and muscle functions. Electrolytes are also involved in oxidation-reduction reactions and participate as essential parts or cofactors in enzyme reactions.[10] The quantitative estimation of electrolytes in the present study was done using ion-selective electrodes (ISEs).

An ISE makes use of the unique properties of certain membrane materials to develop an electrical potential electromotive force (EMF) for the measurements of ions in solution. The electrode has a selective membrane in contact with both the test solution and an internal filling solution. The internal filling solution contains the test ion at a fixed concentration. Due to the particular nature of the membrane, the test ions will closely associate with the membrane on each side. The membrane EMF is determined by the difference in concentration of the test ion in the test solution and the internal filling solution. The complete measurement system for a particular ion includes the ISE, a reference electrode, and electronic circuits to measure and process the EMF to give the test ion concentration. The sodium and potassium electrodes are based on neutral carriers and the chloride electrode is based on an ion exchanger.[10]

Serum or heparinized plasma collected using standard sampling tubes or tubes containing separating gel. Samples should be separated from the clot or cells promptly after collection. Specimens to be tested for potassium must be centrifuged within 1 h of collection. Grossly, lipemic specimens should be cleared by ultracentrifugation. ISE system automatically calculates the electrolyte concentration of each sample. Results are automatically printed for each sample in mEq/L at 37°C.

Statistical Analysis

The present study was designed as a cross-sectional comparative study. Statistical analysis was done to determine the differences between the two groups. The data were analyzed using the Statistical Package for the Social Sciences version 18. The results were expressed as mean ± standard deviation (SD). The mean value of each parameter was obtained by summing up all the individual values in the groups and dividing it by the number of subjects in the groups. The mean differences between the groups were analyzed using independent sample *t*-test. For all statistical tests, $P \leq 0.05$ was taken as the level of statistical significance.

RESULTS

The present study was conducted to evaluate the changes in serum electrolytes, namely Na, K, and Cl in senile cataract patients. One hundred subjects were selected in the age group of 50–80 years and they were categorized into two groups. Fifty were patients with senile cataract and 50 were age- and sex-matched normal healthy individuals. After statistical analysis, the results were expressed as mean ± SD. The results are summarized as figures below. The serum sodium levels were found to be higher in cases compared to controls and the difference was statistically significant ($P = 0.000$) [Figure 1]. There was no significant difference in serum potassium level in cases compared to controls and *P*-value was not statistically significant ($P = 0.476$) [Figure 2]. The serum chloride levels were found to be higher in cases compared to controls and the difference was statistically significant ($P = 0.000$) [Figure 3].

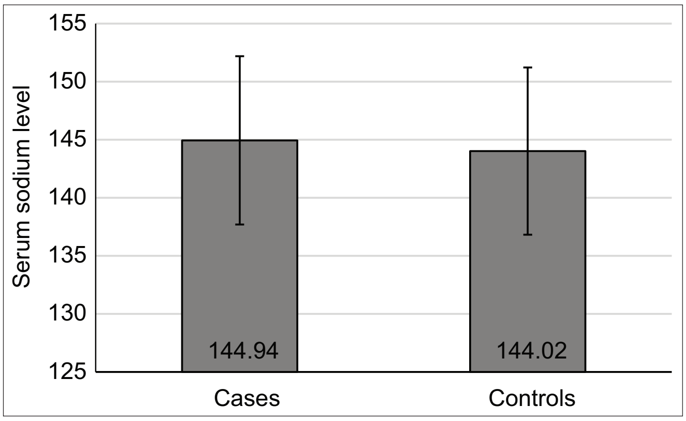

Figure 1: Comparison of serum sodium levels in cases and controls

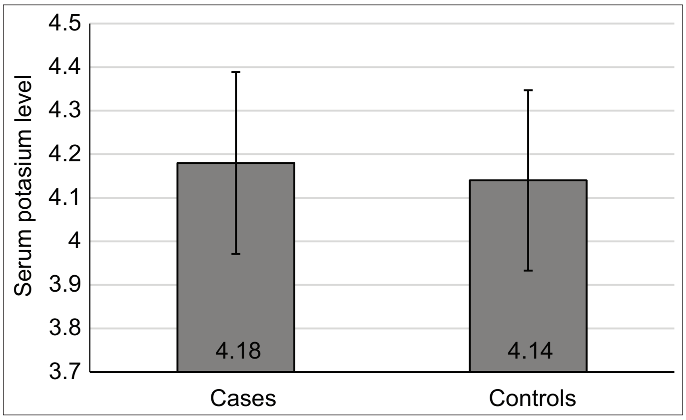

Figure 2: Comparison of serum potassium levels in cases and controls

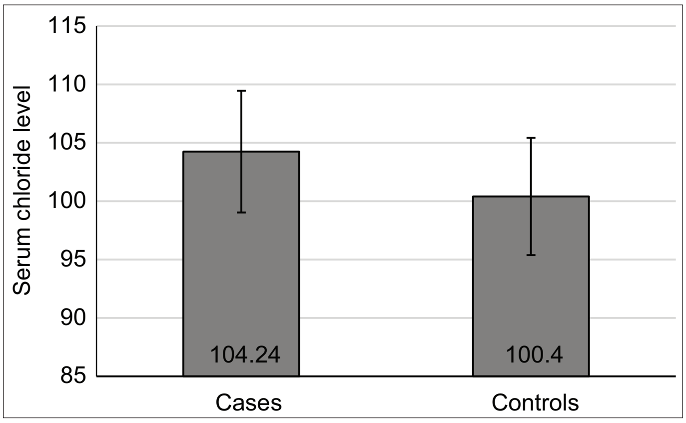

Figure 3: Comparison of serum chloride in cases and controls

DISCUSSION

The present study was done to evaluate the role of serum electrolytes in the development of senile cataract. It was a cross-sectional comparative study done in the Department of Ophthalmology, Government Medical College, Kozhikode. The study showed significantly elevated serum sodium and chloride levels in senile cataract patients as compared to healthy controls. The mean serum sodium in cases (144.94 ± 3.07 mEq/L) was higher than that of controls (140.02 ± 3.43 mEq/L). The difference was statistically significant ($P = 0.000$). The mean values for serum chloride in cases (104.24 ± 2.86 mEq/L) were significantly elevated than that of controls (100.40 ± 2.69 mEq/L) and *P*-value was 0.000. It has also been found that potassium levels were also elevated in cases (4.18 ± 0.36 mEq/L) as compared to controls (4.14 ± 0.32 mEq/L). The rise in serum potassium levels in cases was insignificant as compared to controls ($P = 0.48$).

Many studies in literature got similar results. The study done by Adiga *et al*. also got significantly elevated serum sodium and chloride levels in senile cataract patients as compared to healthy controls. The elevation of serum potassium was not statistically significant in this study similar to the present study.[11] Studies done by Donnelly *et al*., Mirsamadi *et al*., and Lucas *et al*. have proved significantly elevated serum sodium levels in senile cataract patients comparing normal controls.[8,12,13] The significantly high levels of serum chloride comparing controls obtained in the current study were in agreement with the findings of Adiga *et al*. and Soni *et al*.[11,14] Schoenfeld *et al*. and Phillips *et al*. also reported similar findings in serum potassium level as the present study.[15,16]

Age-related cataract is a cause of blindness on a global scale involving genetic and environmental influences. The oxidation of lens protein by free radicals is believed to play an important part in the multifactorial process, leading to lens opacification. It is due to the age-related decrease in efficiency of the body's natural antioxidative mechanisms, including enzymatic and non-enzymatic (antioxidant micronutrients).[17] Oxidative changes, in turn, affect the electrolytes which equally result in disorder in lens membrane permeability between the intracellular and extracellular.[6]

Normally, lens has high concentration of potassium (114–130 mEq/L) and low concentration of sodium (14–26 mEq/L). These two cations are kept in balance with each other by Na^+-K^+ ATPase pump and permeability of the lens capsule.[8] The change in ion permeability of the lens capsule with increasing age can be accounted by the decrease in membrane fluidity as a result of the age-related increase in the cholesterol:phospholipid ratio.[18] The ion permeability of the epithelial cells become more dependent on the Na^+-K^+ ATPase. However, with aging, the Na^+-K^+ ATPase activity is also reduced, which leads to an increase in sodium within the lens. An imbalance in serum sodium levels leads to a rise in the aqueous humor sodium concentrations, which might exceed the capacity of the Na^+-K^+ ATPase pump to maintain a low level of lenticular sodium required for lens transparency. Therefore, higher levels of serum sodium by itself may contribute to the formation of senile cataract.

Lens gets its nourishment from aqueous humor which is a thin fluid produced from serum. The lens metabolism is regulated by aqueous humor electrolytes, which, in turn, is affected by serum electrolytes.[14] In the lens, the concentration of sodium and potassium maintains the osmotic pressure and any alteration in the ratio of these two ions correlates with the increase in optical density of the lens.[19]

The permeability of chloride is high in the lens. The Na^+ K^+2Cl^- cotransporter in the lens has been identified by the dependence of cation flow on anion concentration. A disturbance in the chloride concentration or chloride handling by the lens will affect the ability of the lens to maintain its hydrated state and cause a loss of osmotic equilibrium.[20] The sustained exposure of the lens to osmotic challenges may overwhelm its capacity to regulate volume, leading to unopposed volume changes, a disruption of lens fiber cell structure, formation of fluid-filled pockets in the extracellular space, and a disturbance of the hydration of the lens proteins, all of which increase light scatter and may result in protein aggregation and cataract in long term.[21]

In the present study, there are increased Na^+ and Cl^- levels in senile cataract patients as compared to controls. The level of serum sodium and chloride can act as modifiable risk factors in the development of senile cataract. Dietary salt restriction may help to delay the progress of cataract formation, which can be a preventive measure useful to the community and prevent disabilities and help to improve quality of life, useful for the health-care system.

Limitation of the Study

Clear-cut role of potassium in the etiopathogenesis of senile cataract was not established in the current study. If the sample size was more, more representative data would have been established.

CONCLUSION

The present study was undertaken to evaluate the role of serum electrolytes in the pathogenesis of senile cataract. The study group included 100 subjects, of which 50 were senile cataract patients and 50 were age- and sex-matched controls. Serum electrolytes (Na^+, K^+, and Cl^-) were analyzed among the study group, showed significantly elevated serum sodium and chloride levels in senile cataract patients as compared to healthy controls and an elevation in potassium levels was statistically insignificant.

Disturbances in the concentration of serum electrolytes can alter their concentration in aqueous humor, which might exceed the capacity of pumps and channels present in the lens membrane, resulting in volume overload and lens opacities. Therefore, the level of serum sodium and chloride can be used as markers of senile cataract formation. Furthermore, this study emphasizes that dietary salt restriction has an important role to delay the progress of cataract formation.

REFERENCES

1. Tandon R, Sihota R. Parson's Disease of the Eye. 22nd ed. India: Elsevier; 2015. p. 255-60.
2. Mansoor A, Gul R, Malik T, Khalil M, Alam R. Senile cataract patients; serum electrolytes and calcium. Prof Med J 2015;9:1186-91.
3. Sreelakshmi V, Abraham A. Age related or senile cataract: Pathology, mechanism and management. Austin J Clin Ophthalmol 2016;3:1067.
4. Alshamrani AZ. Cataracts pathophysiology and managements. Egypt J Hosp Med 2018;70:151-4.
5. Harding JJ. The physiology, biochemistry, pathogenesis and the epidemiology of cataracts. Curr Opin Ophthalmol 1991;2:3-15.
6. Johnkennedy N, Magnus N, Elemba JE, Uche UB. Alterations of serum electrolytes and malondialdehyde in cataract patients attending general hospital Owerri. J Krishna Inst Med Sci 2015;4:93-6.
7. Goel M, Picciani RG, Lee RK, Bhattacharya SK. Aqueous

humor dynamics: A review. Open Ophthalmol J 2010;4:52-9.
8. Mirsamadi M, Nourmohammadi I, Imamian M. Comparative study of serum Na(+)and K(+) levels in senile cataract patients and normal individuals. Int J Med Sci 2004;1:165-9.
9. Zhang JJ, Jacob TJ. The role of chloride in the lens of the eye. Exp Physiol 1997;82:245-59.
10. Tietz N. Fundamentals of Clinical Chemistry. 3rd ed. Philadelphia, PA: W.B. Saunders; 1987.
11. Adiga US, Harris A, Ezhilvathani TN, Basu S. Serum electrolytes in senile cataract patients. Al Ameen J Med Sci 2014;7:164-8.
12. Donnelly CA, Seth J, Clayton RM, Phillips CI, Cuthbert J, Prescott RJ. Some blood plasma constituents correlate with human cataract. Br J Ophthalmol 1995;79:1036-41.
13. Lucas VA, Duncan G, Davies P. Membrane permeability characteristics of perfused human senile cataractous lenses. Exp Eye Res 1986;42:151-65.
14. Soni PN, Chabada DS, Wankhede SU, Soni SP. Serum electrolyte changes in senile cataract patients at tertiary care teaching hospital in Marathwada region, Maharashtra, India. Int J Adv Med 2016;3:287-90.
15. Schoenfeld ER, Leske MC, Wu SY. Recent epidemiologic studies on nutrition and cataract in India, Italy and the United States. J Am Coll Nutr 1993;12:521-6.
16. Phillips CI, Bartholomew RS, Clayton R, Duffy J. Cataract: A search for associated or causative factors. Excerpta Medica 1980:34;19-25.
17. Moyong K, Kawanpure H, Kamble P, Kaleon T. Study on oxidative stress in senile cataract. Int J Health Sci 2012;2:8-12.
18. Albert D, Miller J, Azar D, Blodi B. Albert and Jakobiec's Principles and Practice of Ophthalmology. 3rd ed. London: Sanders/Elsevier; 2008. p. 16.
19. Coren S, Girgus JS. Density of human lens pigmentation: *In vivo* measures over an extended age range. Vision Res 1972;12:343-6.
20. Jadav MP, Sharma H, Megha M, Chaudhary A, Maheshwari AV, Javia HN, *et al*. Relationship between altered level of serum electrolytes and risk of senile cortical cataract-a case control Study. SEAJCRR 2013;2:190-4.
21. Zhang JJ, Jacob TJ. Volume regulation in the bovine lens and cataract. The involvement of chloride channels. J Clin Invest 1996;97:971-8.

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