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ESTIMATION OF SERUM ELECTROLYTES (NA^+ AND K^+) AND SERUM CALCIUM LEVELS IN SENILE CATARACT PATIENTS AND ITS COMPARISON WITH NON CATARACT PATIENTS

Prem Prakash Jain[1], Alok Vyas*[2] and Sonal Sogani[3]

[1]Assistant Professor, Department of Ophthalmology, Ananta Institute of Medical Sciences (AIMS), Udaipur (Raj.), 313202.

[2]Assistant Professor, Department of Ophthalmology, Pacific Medical College and Hospital (PMCH), Udaipur (Raj.), 313015.

[3]Assistant Professor, Department of Biochemistry, Pacific Institute of Medical Sciences, Udaipur (Raj.), 313015.

***Corresponding Author: Alok Vyas**

Assistant Professor, Department of Ophthalmology, Pacific Medical College and Hospital (PMCH), Udaipur (Raj.), 313015.

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ABSTRACT

Cataract is the opacification of crystalline lens in the human eye. Age is considered as one of the strongest known risk factor for cataract formation. One of the most important risk factors for cataract formation is serum sodium and serum calcium, although serum potassium is inconclusive. Though ageing cannot be prevented, any physiological changes that occur in electrolytes can be modified. **Aim:** The aim of this study was to estimate the changes in the levels of serum electrolytes and serum calcium in senile cataract patients and its comparison with non cataract patients. **Material and Methods:** Sixty patients (60) with senile cataract within the age of 55 years to 75 years as study group and 60 healthy subjects without cataract within the age of 55 years to 75 years as control group visiting the ophthalmic OPD of Ananta Institute of Medical Sciences (AIMS), Udaipur (Raj.) and were selected for the study. This is the case-control hospital based study. Blood samples collected were estimated for serum sodium, serum potassium, serum calcium and serum glucose. Comparison between both the groups was done by Student's t-test. Study group includes 37 females and 23 males patients. In the control group, there were 42 females and 18 males. The levels of serum glucose, urea and creatinine were also measured in order to rule out diabetes and kidney malfunction in both study and control groups. **Results:** The level of serum sodium was elevated with highly significant difference ($p<0.001$) in senile cataract patients as compared to control group. The level of serum potassium though elevated in study group as compared to the control group but the difference was not significant ($p<0.05$). Serum calcium was elevated in senile cataract group with highly significant difference ($p<0.001$) as compared to control group. **Conclusions:** Our study concluded that the increased levels of serum sodium and serum calcium may be considered as markers of senile cataract formation. The salt restricted diet is advisable in cataract patients so as to maintain normal electrolyte balance which may prevent further progression of disease.

KEYWORDS: Cataract, Electrolyte, Calcium.

INTRODUCTION

Eye is the most important and amazing organ in the human body. It is a complex organ composed of many small parts, but each vital to normal vision. Amongst five senses, vision is the most evolved sense in the human being.[1] Lens is one of the most important structure in the eyes. The main function of the lens is to refract the light to focus it on the retina that lies behind pupil and iris. This lens is mainly composed of water and protein and the protein is arranged in a way that keeps the lens clear and allows the light to pass through it.[2] When any opacification in crystalline lens occurs, cataract is formed. Cataract is thus the clouding or opacity that develops in the eye lens and is formed by bounding or folding of protein changes and clumps together. Theses clumps cloud the lens and block the light. This is simply a cataract that grows with time and makes the lens cloudy and thus vision becomes difficult.[3] Globally, 50% of blindness is caused by cataract and thus it remains the leading cause of visual impairment all over the world, despite improvements in surgical outcomes.[4] In India, alone it account for 80% of treatable blindness.[5]

Senile cataract is one of the most commonest types of cataract which occurs as a consequences of the aging process. It is physiological disorder of the eye which is characterized by an initial opacity in the lens with subsequent swelling of the lens and final shrinkage with complete loss of transparency.[6] Approximately 75% of population above the age of 75 years suffers from cataract.[7,8] The term senile actually means that there is no specific ophthalmic or metabolic diseases which are involved in this type of cataract.[9] In most cases it leads to blindness and is characterized by blurred vision.[10] Generally, cataract begins with little effect on vision and the vision may be blurred or hazy.[11]

Although the exact pathogenesis of cataract formation is yet not known, there are many risk factors which are proposed for the cataract formation. These risk factors are age, sex, radiation, genetics, metabolic disorders,[8,12] protein aggregates,[13] oxidative stress,[14] post translational protein changes,[15,16] phase separation.[17] Combined factors of heritage, UV light exposure, diet, some of the metabolic disorders, quality of life, cationic pump malfunction and lens metabolism disorder are believed to have role in cataract formation.[18]

The lens metabolism is associated with aqueous humor.[19] The main source of nourishment for the lens is the aqueous humor as lens itself is avascular. It is the thin fluid produced from the serum So normal serum electrolytes are required to maintain proper water electrolyte balance all over the body. The serum electrolytes directly affects the electrolytes of aqueous humor and thus regulates lens metabolism.[8] As aqueous humor is derived from the plasma, derangement in serum electrolytes is thus considered as one of the important risk factor for cataractogenesis.

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. As the disease cannot be prevented from occurring, some important measures are to be taken to slow down the development of the cataract.

So the present study was undertaken to evaluate the plasma level of Na^+, K^+, and Ca^+ in age related cataract cases and compared with control group without cataract.

MATERIAL AND METHODS

The patients were selected from those who were admitted for cataract extraction in the ophthalmology department, Ananta Institute of Medical Sciences (AIMS), Udaipur (Raj). Study group includes sixty patients (60) with senile cataract within the age of 55 years to 75 years as and control group includes sixty (60) healthy subjects without cataract within the age of 55 years to 75 years. Slit lamp examination, visual acuity determination and intraocular pressure measurement was done for study group. The subjects of the control group were selected on the basis of the visual activity of 6/6 or better in both eye and no lens opacities in either eye on slit lamp or ophthalmoscopic examination along with intraocular pressure measurement. The patients with chronic liver diseases, kidney diseases, cardiovascular diseases, rheumatoid arthritis, carcinoma, diabetes mellitus, hypertension, thyroid disorders, any kind of complicated cataract, those on any kind of drug like steroids which alter the electrolytes, or those taking the drugs that may influence the redox state of lens and oxidative stress, smokers, alcoholics were excluded from the study. Also patients with ocular surgery, trauma, infection and inflammation of the eye were also excluded from the study.

Sample collection

In all subjects, 5ml of fasting venous blood was collected into plain vials. The serum was separated by centrifuging the whole blood in REMI R-8C centrifuge machine at 5000g for 5 minutes.

Estimation of biochemical assay

Serum sodium and potassium were measured by using the electrolyte analyzer-Easylyte Na/K analyzer which works on the principle of ion selective electrodes. Serum calcium was measured by Arsenazo method and Serum glucose was measured by GOD - POD method using fully automated biochemistry analyzer-Cobas c-111.

Statistical Analysis

All the data were expressed as mean ± SD. The statistical significance was evaluated by Student's t-test using SPSS software, version 20. The level of significance was set at < 0.05.

OBSERVATIONS

Table 1: Comparison of mean and standard deviation of biochemical parameters of Study and Control groups.

Biochemical parameters	Study group (senile cataract patients) (n=60)	Control group (Healthy subjects without senile cataract) (n=60)
	Mean ± SD	Mean ±SD
Serum sodium (mEq/l)	147.3 ± 2.3**	137.6 ± 4.3
Serum potassium (mEq/l)	4.10 ± 0.26*	4.07 ± 0.26
Serum calcium (mg/dl)	8.43 ± 0.67***	8.68 ± 1.20
Serum glucose (mg/dl)	85.18 ± 6.91*	84.12 ± 11.2

*p > 0.05- compared with healthy subjects without senile cataract, **p <0.0001- compared with healthy subjects without senile cataract, ***p<0.05 - compared with healthy subjects without senile cataract.

RESULTS

The study includes 60 patients suffering from senile cataract (37female, 23male) and the control group consist of 60 healthy subjects who were attending the OPD for regular checkup or patient's bystanders (42female, 18male). Age group of study and control groups was between 55 years to 75 years respectively. Reference range for sodium was taken as 135-145 mEq/L, for potassium is 3.5-5.0 mEq/L. The levels of serum sodium in senile cataract patients were found to be significantly higher ($p<0.0001$) as compare to controls While serum potassium levels showed no significant difference ($p>0.05$) between both the groups. Reference range for calcium and glucose were taken as 9-11 mg/dl and up to 140 mg/dl respectively**.** On measuring the levels of serum calcium in both the groups, decreased level was observed in senile cataract patients when compared with controls with significant difference ($p<0.05$). Serum glucose showed no significant difference ($p>0.05$) in both the groups. Values are depicted in table no 1.

DISCUSSION

Cataract results in the clouding of lens inside the eye which results in the reduction in vision. Globally, it is the most common cause of blindness and can be treated with surgery.[10,21] Various studies are going all over the world to clarify the relationship between human biochemical elements and cataract formation. Many different mechanisms such as protein aggregation, oxidative stress, osmotic gradient, and nutritional factors have been identified.[7] In this study the sodium was significantly higher and potassium showed no significant difference when compared with control. Elevation in serum sodium levels is in accordance with the studies by Rewatkar et al,[7] Mathur et al.[22] and Gaurav M et al.[23] Our results were in consistence with the conclusions drawn by various studies even though controversies exist.[24,25] Thus the study concluded that exposure to sodium in the absence of other biochemical risk factors remained the most significant risk factor for the development of senile cataract.

Normally to maintain lens membrane permeability, water electrolyte balance must be maintained intracellularly and extracellularly. Membrane permeability is thus responsible for lens transparency. Sodium is major serum extracellular cation while potassium is major serum intracellular cation. In lens, concentration of sodium is less than potassium while in serum it is vice versa. This cation balance maintains osmotic pressure and thus water balance across the lens membrane with the action of Na^+ K^+ ATPase. With ageing, there is an increase in membrane permeability of the lens cells due to reduced activity of Na^+ K^+ ATPase pump, which increases internal Na^+. Higher levels of extracellular Na^+ might make it more difficult for Na^+ K^+ ATPase pump to maintain the low levels of intracellular Na^+ required for lens transparency.[26] Variation of electrolytes in the serum in turn alters cation concentration of aqueous humors, which ultimately affects lens metabolism leading to cataract formation.[27] Thus the elevation of sodium and stability of potassium is dangerous to the eye lens as shown by West and Valmarid in their work.[28] This elevation of sodium could be linked with age as the lens protein denature and degrade over time. This process in increased by diabetes and hypertension.

Other probable causes for the formation of cataract besides the elevated sodium levels could be the environmental factors like toxins, UV light that may have cumulative effects, changes in gene expression and chemical process taking place in the eye. Damage to the DNA could affects the lens cells, heart injuries can denature the lens and thus affect the sodium potassium ATP ase enzyme leading to alteration in sodium.[29]

In our study the low serum calcium level was observed in senile cataract patients when compared with controls with significant difference ($p<0.05$). Though study done by Zhonghua and Chen CZ clearly supported our results.[30] Although our results were contrary with some studies.[31,32]

In the lens, there is a different cell that appears to be specialized such that some have a high capacity for energy-dependent ion transport while other cells do not. This describes the distribution of functional Ca-ATPase activity i.e. activity of Ca pump in the lens. The expression of different Ca-ATPase isoforms in lens epithelium and fiber cells is considered along with mechanisms that potentially regulate the activity of these transport proteins. Thus cataract during the early stage of hypocalcaemia is caused by membrane damage with low calcium in the aqueous humor and increase sodium content in the lens.[33] Similarly the cataract of parathyroid tetany is suggestive of the inter relationship between the serum calcium concentration and cataract. Although the studies done by Duncan G et al,[34] and Frank J et al,[35] were in contradictory to our studies who concluded that the accumulation of calcium in the intact lens induces the formation of high molecular weight proteins which may be associated with the loss of lens transparency.

Although from many studies, the results are diverse. According to the molecular research, there are three types of ionic channels in the lenses, where the calcium channel is the smallest one and those for sodium and potassium movements, the channels are the largest one.[36] With the age, the transmembrane potential of human eyes decreases. Increases in cation permeability are balanced by increase in the pump activity. This removes the sodium and calcium from the lens. But still despite of all this, the free calcium and sodium levels increases in the cytoplasm of older lenses. As sodium and calcium channels are found in lens epithelium, their effect on lens transparency is more important. Thus it is seen that whether the serum levels of sodium, potassium or calcium are too low or too high, the efficiency of these channels are at stake. This ultimately results in the loss of lens transparency.[37]

CONCLUSION

Studies on serum electrolytes (sodium and potassium) and serum calcium concluded that senile cataract is a mutifactorial disease and along with cataract there are some other factors which contribute to the aging lens changes. Elevation of serum sodium may be one of the most important risk factor for the development of cataract. To prevent the further progression of cataract, salt intake in the diet may be strictly restricted in such patients who may delay maturation and progression of cataract.

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