

# Correlation of aqueous humor electrolytes with serum electrolytes in cataract patients

Amol Bansal, Hrishikesh Amin, Rekha R<sup>1</sup>

**Purpose:** To correlate the aqueous humor electrolytes with serum electrolytes in patients with cataract. **Methods:** In this study, 348 eyes of patients undergoing cataract surgery, who had presented between 1<sup>st</sup> January 2019 and 30<sup>th</sup> June 2020, were included. Serum electrolytes were obtained and 0.15 ml of aqueous humor was obtained during surgery using an insulin syringe via the side port incision. Mean and standard deviation was used to analyze all the categorical and continuous data including all the electrolytes levels. Pearson's correlation of coefficient was used to analyze the comparison between serum and aqueous humor electrolytes. Student T-test was used to compare electrolyte values between the serum and aqueous humor. **Results:** We observed a significant correlation of the aqueous humor electrolytes with their serum counterparts. The coefficient of correlation is 0.155, 0.44, and 0.405 for Na<sup>+</sup>, K<sup>+</sup>, and Cl<sup>-</sup>, respectively. There is also a significant increase in the aqueous humor electrolytes as compared to the serum levels. **Conclusion:** A significant increase in electrolytes levels in the aqueous humor of cataract patients possibly could have a role in the etiology of cataract.

**Key words:** Aqueous humor, cataract, electrolytes

Access this article online

Website:

www.ijo.in

DOI:

10.4103/ijo.IJO\_20\_21

Quick Response Code:



Cataract, the opacification of the crystalline lens, causes a reduction in the light entering the eye causing diminution of vision.<sup>[1]</sup> It is one of the leading causes of treatable blindness in the world with a prevalence of 71.8%.<sup>[2]</sup> Around 68% of the population above 79 years have cataract.<sup>[3]</sup>

It is known that changes in electrolyte levels in aqueous humor play a role in cataractogenesis.<sup>[4]</sup> Various earlier studies analyzed the changes in serum electrolytes concerning cataract formation,<sup>[5-7]</sup> but the effects of changes in the levels of serum electrolytes on those in aqueous humor have not been reported earlier. Here we aim to find a correlation between the serum and aqueous humor electrolytes in cataract patients.

## Methods

We conducted an observational study that included 348 eyes of 336 patients based on the need for cataract surgery. The study was conducted from January 2019 to June 2020. Patients who had chronic kidney disease, prior ophthalmic surgeries, traumatic cataract, complicated cataract, or steroid-induced cataract were excluded from the study. Written informed consent was taken from all the participants. 0.15 ml aqueous humor was collected using an insulin syringe after making a side port incision and transported to the biochemistry lab in the same syringe immediately for the estimation of sodium, potassium, and chloride levels.

Estimation was done using IS internal standard, IS reference electrolyte, and IS diluent solutions in Cobas c 311 machine. Serum levels were estimated using preoperative blood samples along with sugar levels. Statistical analysis was done using Pearson's correlation coefficient to analyze the correlation between serum and aqueous humor electrolytes.

All samples were procured after taking written informed consent from each patient. Ethical clearance was taken from the Institutional Ethics Committee.

## Results

348 eyes of 336 patients were included in the study. The mean age group was 62.35±10.08 years. There were 168 males (52%) and 180 females (48%). 195 patients had mixed type of cataract, 51 patients had mature cataract, and 74 patients had nuclear sclerosis.

The mean aqueous humor levels for sodium was 146.48±6.59 mEq/L, for potassium was 4.15±0.305 mEq/L, and for chloride was 118.3±5.49 mEq/L [Table 1]. The Pearson's correlation coefficients between the aqueous humor values and serum values of sodium, potassium, and chloride were 0.155, 0.44, and 0.405 with a *P* value of 0.004, <0.05, and 0.405, respectively [Table 1 and Figs. 1-3].

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow\_reprints@wolterskluwer.com

Cite this article as: Bansal A, Amin H, Rekha R. Correlation of aqueous humor electrolytes with serum electrolytes in cataract patients. Indian J Ophthalmol 2021;69:2675-7.

Departments of Ophthalmology and <sup>1</sup>Community Medicine, K.S.Hegde Medical Academy, Justice K.S.Hegde Charitable Hospital, Deralakatte, Mangalore, Karnataka, India

**Correspondence to:** Dr. Amol Bansal, Department of Ophthalmology, Justice K.S.Hegde Charitable Hospital, Deralakatte, Mangalore - 575 018, Karnataka, India. E-mail: amolbansal1992@gmail.com

Received: 03-Jan-2021

Revision: 07-Mar-2021

Accepted: 13-Jun-2021

Published: 25-Sep-2021

We also found the sodium and chloride levels in the aqueous humor to be higher than their values in serum, which was statistically significant ( $P < 0.0001$ ). Potassium did not show any such difference between the two ( $P = 0.74$ ).

Comparison of aqueous humor and serum electrolytes between males and females was done for each of sodium, potassium, and chloride which did not show any significant difference,  $P$  value being  $>0.05$  for each.

### Discussion

Cataract, as we know, has been and still is the leading cause of treatable blindness worldwide, which is the cause for 47.8% of blindness.<sup>[8-10]</sup> In India itself cataract accounts for 80% of the blindness.<sup>[10,11]</sup> Nirmalan *et al.*<sup>[12]</sup> reported the prevalence of cataract in southern India to be 47.5% in their study group. They also showed that the prevalence was higher in women as compared to men. Singh *et al.*<sup>[10]</sup> also reported a prevalence of 44.68% and 43.62% in rural and urban population, respectively.

Though many theories have been put forward regarding cataract formation, exact etiological factors and the precise pathophysiological mechanism for cataractogenesis are yet to be identified. Risk factors that have been associated with cataract formation include ultraviolet light exposure, diabetes, hypertension, smoking, and advancing age, the latter being the most important risk factor known so far.<sup>[10]</sup>

There have been studies that have tried to find the biochemical factors that play a role in cataract formation. A study done by Rewatkar *et al.*<sup>[13]</sup> showed an elevation of serum sodium levels in cataract patients as compared to non-cataract patients with the mean sodium being  $148.52 \pm 4.13$  mEq/L and  $139.26 \pm 3.08$  mEq/L, respectively. They concluded that serum sodium levels could be used to determine the risk of cataract.

Mathur and Pai studied serum sodium and potassium levels in a group of cataract patients and showed a significantly higher level of serum sodium levels in them as compared to the group not having cataract, the values being 135 mEq/L and 133.1 mEq/L, respectively,  $P$  value being  $<0.001$ . Their study showed no significant increase in potassium levels in cataract patients. They concluded that a high sodium diet could be a risk factor for the development of cataract.<sup>[5]</sup>

Mirsamadi *et al.*<sup>[6]</sup> also studied serum sodium and potassium in cataract patients compared with non-cataractous patients. They showed a significantly higher levels of serum sodium in patients who had cataract ( $144.96 \pm 6.04$  mEq/L) as compared to patients who did not ( $140.88 \pm 2.27$  mEq/L), the  $P$  value being  $<0.0001$ .

Khan *et al.* also studied the change in serum electrolytes in cataract patients as compared to age-matched controls in the Indian population. They reported serum sodium levels of

$145.39$  mEq/L  $\pm 3.04$  mEq/L and  $139.63$  mEq/L  $\pm 13.91$  mEq/L in the two groups, respectively ( $P < 0.01$ ). They concluded that age-related cataract tends to have higher serum sodium levels than age-matched controls.<sup>[7]</sup>

Now, the crystalline lens being an avascular structure, the only way, probably, an increase in serum electrolytes levels that could influence cataract formation could be by altering the electrolytes levels in aqueous. None of the above studies, however, included the estimation of electrolytes levels in aqueous humor electrolytes in their protocol, to prove this premise.

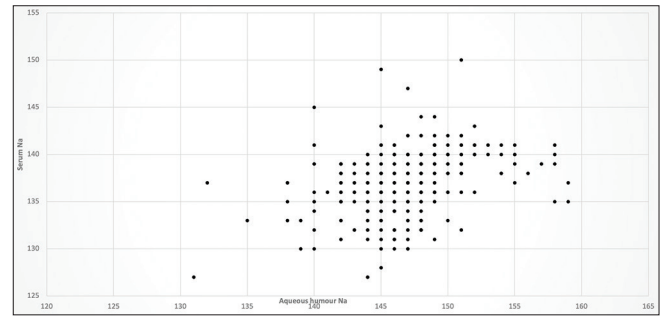


Figure 1: Scatter plot between aqueous and serum sodium

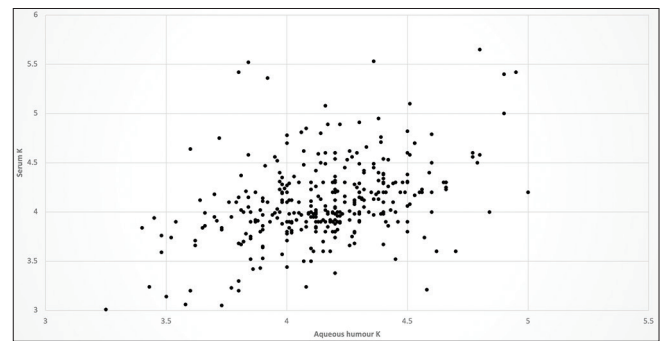


Figure 2: Scatter plot between aqueous and serum potassium

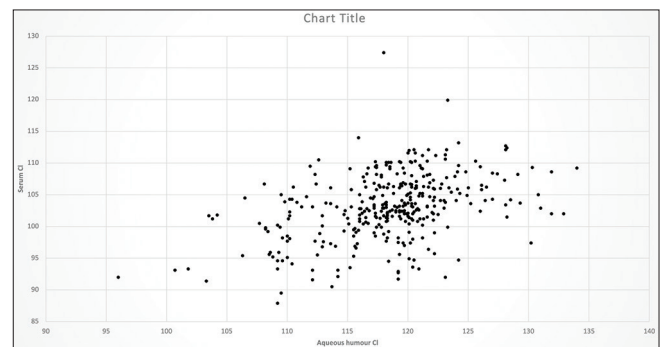


Figure 3: Scatter plot between aqueous and serum chloride

Table 1: Mean electrolyte levels in aqueous humor and serum with their correlation coefficient

	Mean Na (SD)	Mean K (SD)	Mean Cl (SD)
Aqueous humor	146.48 (6.59)	4.15 (0.305)	118.3 (5.49)
Serum	136.98 (3.83)	4.10 (0.42)	103.09 (5.69)
Correlation coefficient- $r$ ( $p$ )	0.155 (0.004)	0.44 ( $<0.001$ )	0.405 ( $<0.001$ )

Na - Sodium; K - Potassium; Cl - Chloride; SD - Standard Deviation

In our study, we estimated both serum and aqueous levels of electrolytes with an aim to find a correlation between the aqueous humor and serum electrolytes levels in cataract patients and thus showing that changes in serum electrolytes levels played a role in cataractogenesis by altering the lens metabolism through alteration in the aqueous electrolytes levels by altering the lens metabolism. Our results showed a significant correlation of aqueous sodium, potassium, and chloride levels with their serum counterparts (sodium:  $r = 0.155$ ,  $P = 0.004$ ; potassium:  $r = 0.44$ ,  $P < 0.001$ ; chloride:  $r = 0.405$ ,  $P < 0.001$ ). Thus, we can infer from these results that an alteration in serum electrolytes levels would influence lens metabolism by altering the levels of aqueous electrolytes.

A major clinical significance of these observations could be the possibility of use of certain drugs in topical form, for example, carbonic anhydrase inhibitors, which can influence the Na<sup>+</sup> pump mechanism of the crystalline lens for effecting a reduction in the ionic imbalance in the aqueous and consequently cause reduction or cessation of the progression of cataract.

Our results also showed that aqueous humor sodium and chloride levels were significantly higher than their serum counterparts (sodium: 146.48 mEq/L and 136.98 mEq/L, respectively,  $P < 0.0001$ ; chloride: 118.3 mEq/L and 103.09 mEq/L, respectively,  $P < 0.0001$ ), while potassium levels were similar in the two fluids (4.15 mEq/L and 4.10 mEq/L respectively,  $P = 0.74$ ). This indicates an increased concentration of electrolytes in the aqueous in cataract patients. On the other hand, an earlier study by Consul *et al.*<sup>[14]</sup> showed that there was a slight decrease in aqueous humor electrolytes levels as compared to their serum counterparts in cataract patients. This is in stark contrast to our study which shows a significant increase in electrolyte values in the aqueous. However, the sample size in that study was very small ( $n = 28$ ) and that could be the reason for the difference in our observations.

There have been many theories to explain the ionic movement inside the lens. One such theory explains that the fibers in the crystalline lens consist of a sodium-potassium ATPase pump which generates an electric potential across the lens surface with the inside of the lens being negative. This causes the flow of Na ions into the lens which in turn cause water to flow into the lens via the anterior epithelium and is extruded at the posterior surface into the vitreous.

Thus, our study brings out that the altered serum electrolytes levels cause the change in aqueous electrolytes levels, which in turn could be responsible for impairment in the normal ionic homeostasis which may play a role in cataract formation. Since our study did not take into account the non-cataractous population, we cannot conclude with absolute certainty about the causative nature of the altered electrolytes in cataractogenesis. Future studies can incorporate normal patients and try to find a causative link between the two.

Our study also provides aqueous humor electrolyte values in cataract patients which, to the best of our knowledge, has not been widely documented, except for one such study mentioned earlier, having a very small sample size.

The major limitation in our study is the lack of age-matched controls which would have allowed us to find a direct correlation between change in aqueous humor electrolytes levels and cataract formation. Future studies can incorporate

a control group of non-cataract patients to compare the change in aqueous electrolytes between the two with a larger sample size. It will also be useful to study the effect of diseases causing electrolyte imbalances (like chronic kidney diseases) on aqueous electrolytes levels and their association with cataract.

## Conclusion

There occurs a significant increase in the electrolyte levels in the aqueous humour of cataract patients which could have a role in formation of cataract.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## References

- Gupta VB, Rajagopala M, Ravishankar B. Etiopathogenesis of cataract: An appraisal. *Indian J Ophthalmol* 2014;62:103.
- Vashist P, Talwar B, Gogoi M, Maraini G, Camparini M, Ravindran RD, *et al.* Prevalence of cataract in an older population in India the India study of age-related eye disease. *Ophthalmology* 2011;118:272-8.
- Weikel KA, Garber C, Baburins A, Taylor A. Nutritional modulation of cataract. *Nutr Rev* 2014;72:3047.
- Michael R, Bron AJ. The ageing lens and cataract: A model of normal and pathological ageing. *Philos Trans R Soc Lond B Biol Sci* 2011;366:1278-92.
- Mathur G, Pai V. Comparison of serum sodium and potassium levels in patients with senile cataract and age-matched individuals without cataract. *Indian J Ophthalmol* 2016;64:446.
- 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.
- Khan AA, Rizvi SW, Amitava AK, Moin S, Siddiqui Z, Yusuf F. Serum Na<sup>+</sup> and K<sup>+</sup> as risk factors in age-related cataract: An Indian perspective. *Sudan J Ophthalmol* 2014;6:10.
- Rao GN, Khanna R, Payal A. The global burden of cataract. *Curr Opin Ophthalmol* 2011;22:4-9.
- Liu Y-C, Wilkins M, Kim T, Malyugin B, Mehta JS. Cataracts. *Lancet Lond Engl* 2017;390:600-12.
- Singh S, Pardhan S, Kulothungan V, Swaminathan G, Ravichandean JS, Ganesan S, *et al.* The prevalence and risk factors for cataract in rural and urban India. *Indian J Ophthalmol* 2019;67:477-83.
- Dandona L, Dandona R, Srinivas M, Giridhar P, Vilas K, Prasad MN, *et al.* Blindness in the Indian state of Andhra Pradesh. *Invest Ophthalmol Vis Sci* 2001;42:908-16.
- Nirmalan PK, Robin AL, Katz J, Tielsch JM, Thulasiraj RD, Krishnadas R, *et al.* Risk factors for age related cataract in a rural population of southern India: The Aravind Comprehensive Eye Study. *Br J Ophthalmol* 2004;88:989-94.
- Rewatkar M, Muddeshwar MG, Lokhande M, Ghosh K. Electrolyte imbalance in cataract patients. *Indian Medical Gazette* 2012;89-91.
- Consul BN, Taunk JP, Mathur GB. Human aqueous electrolytes. *Indian J Ophthalmol* 1969;17:52-4.