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Research Article

**CORRELATION OF INTRA OCULAR PRESSURE WITH
SERUM ELECTROLYTES IN HYPERTENSIVE AND NON-
HYPERTENSIVE PATIENTS****Dr Rehab Habib¹, Dr Rana Mohammad Mohsin Javed², Dr Farhat Ijaz³, Dr Rana
Khurram Aftab⁴, Dr Hira Sohail⁵, Dr Mussarat Ijaz⁶**^{1,4} King Edward Medical University, Lahore, ² Mayo Hospital, Lahore, ^{3,5} CMH Lahore Medical
College (NUMS), Lahore, ⁶ Islamia University of Bahawalpur, Bahawalpur.**Article Received:** October 2019 **Accepted:** November 2019 **Published:** December 2019**Abstract:**

Hypertension is a common medical disease which affects population all over the world including Pakistan. Crisis in raised blood pressure accounts for about one fourth of all medical emergencies. Higher blood pressure is the main independent determinant of higher intraocular pressure. Electrolytes play an important role in hypertension. Therefore we conducted this study to compare serum levels of sodium, potassium and chloride in hypertensive and non-hypertensive patients and find out their correlation with Intraocular pressure at tertiary care hospital of Lahore.

Material and methods: We conducted this study at Mayo Hospital Lahore & 108 subjects were enrolled in our study who were divided in 2 groups having 54 subjects in each group. Written Informed written permission was taken. Blood pressure was determined by mercuric sphygmomanometer while IOP was assessed by Goldmann applanation tonometer by using 2 % fluorescein strips. 5ml of blood sample was drawn to determine the level of serum electrolytes.

Results: In our study mean age of patients with hypertension was 56.37±6.71 years and non-hypertensive patients were 52.35±5.92 years. IOP was significantly higher in right and left eye in hypertensive patients ($p<0.001$). Serum Na⁺ level was significantly higher while K⁺ was significantly lower in hypertensive subjects ($p<0.001$). Mean serum Cl⁻ was lower in hypertensive though not significant.

Conclusion: We concluded that hypertensive patients had significantly higher levels of serum sodium while we found significant lower levels of serum potassium & chloride. We found a positive correlation between serum electrolytes and intra ocular pressure. Raise in serum sodium is directly related to increased blood pressure which in turn raises the intra ocular pressure

Keywords: Hypertension, IOP, Na⁺, K⁺**Corresponding author:****Dr Farhat Ijaz,**

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INTRODUCTION:

Hypertension has become an epidemic disease worldwide and it is the leading cause of heart attacks, renal failure, stroke and premature deaths. It is estimated that almost about 17 million deaths every year occur due to cardiovascular diseases worldwide out of which as much as 9.4 million deaths are because of hypertension complications. Prevalence of hypertension is rising faster in low and middle economy countries as compared to developed countries like USA. Risk of hypertension increases with low physical activity, high salt intake, use of tobacco and unhealthy diet. Aging is also an important risk factor [1-3]

According to World Health Organization (WHO) in 35% of adult Asian population hypertension has become an important health issue. Although no systematic review and meta-analysis has been carried out but recent WHO estimates have shown that hypertension prevalence is higher in SAARC region. Furthermore there are no guidelines in most of the member states of SAARC for control and prevention of hypertension [3,4]

In a latest systematic appraisal and meta-analysis hypertension ranges from 13.6 %---47.9 %, it is more prevalent in urban areas and in females as compared to males. Its prevalence in different countries of SAARC region showed that 33.8 % of population of Nepal is hypertensive which is maximum prevalence in this region with Maldives, India, Pakistan, Bhutan, Sri Lanka and Bangladesh have prevalence of hypertension in descending order [4]

The reported high rate of hypertension prevalence in SAARC region could be due to epidemiological disease transition pattern from communicable disease to non-communicable disease. Population affected by hypertension has increased because of aging, population growth and due to presence of risk factors like alcohol abuse, unhealthy dietary habits, excess weight, lack of physical activity and persistent stress. Higher hypertension prevalence in urban areas attributes to these changes but it is just a hypothesis because of lack of consistency in studies [4]

Hypertension is a very common medical disease which affects population, all over the world including Pakistan [5] It is a key amendable risk factor of morbidity and mortality related to cardiovascular system, predominantly for ischemic heart disease, stroke, chronic kidney disease, congestive heart failure and peripheral arterial disease [6] It has been noted that in Pakistan incidence of hypertension has raised from 35% in 2008 which was just 17% back in

19806. Rising hypertensive prevalence along with a poor control marks it as a condition which requires serious medical attention [6]

Hypertensive emergency symbolizes more than one-fourth of all medical emergencies. It is commonly presented with headache, epistaxis, psychomotor agitation, chest pain dyspnoea, and neurological deficit [7]. Possible cause of uncontrolled hypertension in Pakistan is deficiency of awareness, knowledge, observance and attitudes of Pakistani hypertensive patients [7]

Intraocular pressure (IOP) is the pressure inside the eyeball. It is due to a balance between aqueous humour production and drainage. In general population, it ranges from 11-21 mmHg with no absolute value. It varies with age, blood pressure, central corneal thickness, vascular disease and diabetes. Normally, IOP shows diurnal variation tending to be higher in morning and lower in evening. It shows diurnal variation of 5 mmHg8 .Hyperopic eyes show a larger diurnal variation as compared to myopic eyes. It can be measured with indentation, applanation and pneumatic methods. But gold standard measurements can be recorded with Goldmann applanation tonometer which is based on Imbert-Fick principle [9]

Higher blood pressure is the main independent determinant of higher IOP [10]. Increased salt intake is associated with hypertension due to increased serum sodium concentration and also increased intake causes resistance to antihypertensive treatment. Hypertension is associated with hypokalemia while low serum chloride is associated with higher mortality in hypertensive population, so all these parameters suggest important correlation of serum electrolytes with hypertension and thus also correlate well with intraocular pressure [11].A pilot study was conducted for this topic as there is no study available in local literature as well as internationally in which all these parameters (IOP, CCT, age, gender & serum electrolytes) were compared in hypertensive and non hypertensive subjects. This pilot study was also important to calculate the sample size for this study.

As IOP and CCT were determined in Pakistani population in previous studies but their important correlation with variables like age, gender, blood pressure and serum electrolytes are not yet determined so we conducted this study to correlate all these factors in both hypertensive and non-hypertensive population to generate new data for our population directly disturbing the management of

patients having glaucoma [12]

Intake of diet with high salt is linked with increase of blood pressure so we can say that sodium rich diet is related to a blood pressure rise while it is observed that potassium rich diet reduces blood pressure. But this doesn't mean to restrict salt in diet and promote potassium rich diet. In contrast to that in hypertensive patients it is seen that salt restriction and promotion of fruits and vegetables is associated with reduction of blood pressure [13]

Human body's most prevalent cat ion is potassium ion. Its plasma concentration is 3.5-5 mmol/l that is 30 times less than its conc. in cells which is around 150 mmol/l (99% of whole body K⁺). The small plasma K⁺ is managed by internal distribution (liver & muscle storage), external intake and excretion [14] normally in a healthy person, dietary potassium's 90% amount is absorbed and then all of it is excreted by kidneys from where in proximal tubule it is again reabsorbed. However kidney regulates potassium's excretion by the cortical collecting duct. Serum aldosterone, distal sodium delivery (hence dietary sodium intake) are the main factors regulating potassium secretion while other factors affecting potassium secretion are acid base balance, rate of urinary flow and variation of high potassium diet [15]

There are many factors in the environment that affect BP and among all of this dietary sodium chloride are the most important. It is thought that BP increases as intake of sodium chloride increases. There is strong evidence that as opposed to sodium, chloride's role is even more important than sodium in BP regulation. Although sodium is almost 85 % consumed along with chloride in diet but there are also other sources of chloride so their concentrations do not relate to each other and this supports the critical role of chloride as an independent entity in BP regulation. Hence chloride's independent role in hypertension is supported by this evidence and this fact has clinical implications in addition to flourishing our knowledge of electrolyte related BP regulation.[16]

Above discussion clearly tells us that electrolytes play an important role in hypertension which has

direct relationship with intraocular pressure. Therefore we conducted this study to compare serum levels of sodium, potassium and chloride in hypertensive and non-hypertensive patients and find out their correlation with Intraocular pressure at tertiary care hospital of Lahore.

METHODOLOGY:

After taking approval from Ethical committee of KEMU we conducted this cross sectional study at Physiology department of KEMU, Lahore in collaboration of Ophthalmology department of Mayo Hospital, Lahore. A total of 108 subjects (54 controls and 54 hypertensive) were enrolled in our study. Informed written permission was taken from the patient's age between 45-65 years. Complete eye examination was done. Blood pressure was measured with mercuric sphygmomanometer in sitting position and average of three readings was taken. IOP was measured by Goldmann aplanation tonometer after anesthetizing the eye with topical proparacaine 0.5% and 2% fluorescein strips. Three consecutive readings were recorded. 5 ml of blood sample was drawn using aseptic measure for the determination of serum electrolytes by Easylyte Plus Na/K/Cl Analyzer.

Collected data was entered and evaluated using SPSS version 17. Mean \pm SD was given to quantitative variables. Correlation coefficient was used to determine the linear correlation among IOP, BP and serum electrolytes. P value \leq 0.05 was considered statistically significant.

RESULTS:

Our study found the mean age of patients with hypertension as 56.37 \pm 6.71 years and without hypertension as 52.35 \pm 5.92 years. Mean IOP of right and left eye was 17.38 \pm 3.99 and 18.77 \pm 6.86 in hypertensives and 14.05 \pm 3.98 and 15.09 \pm 2.84 in non-hypertensives respectively. Mean serum Na⁺ levels in hypertension was 140.07 \pm 3.26 and non-hypertensive patients was 138.66 \pm 2.88 which is statistically significant (p=0.019). Serum K⁺ level was significantly low in hypertensive (3.44 \pm 0.32) than non-hypertensive (3.80 \pm 0.23, p<0.001). Serum Cl⁻ was also reduced in hypertensives (102.64 \pm 3.15) than in non-hypertensives (103.70 \pm 2.31) though not statistically significant.

Table 1: Comparison of Serum electrolytes, IOP and Age in hypertensive and non-hypertensive patients.

Parameters	Hypertensives	Non-hypertensives	p-value
Age (n=54)	56.37±6.71	52.35±5.92	
IOP (Right eye)	17.38±3.99	14.05±3.98	0.000
IOP (Left eye)	18.77±6.86	15.09±2.84	0.000
Na+	140.07±3.26	138.66±2.88	0.019
K+	3.44±0.32	3.80±0.23	0.000
Cl-	102.64±3.15	103.70±2.31	0.05

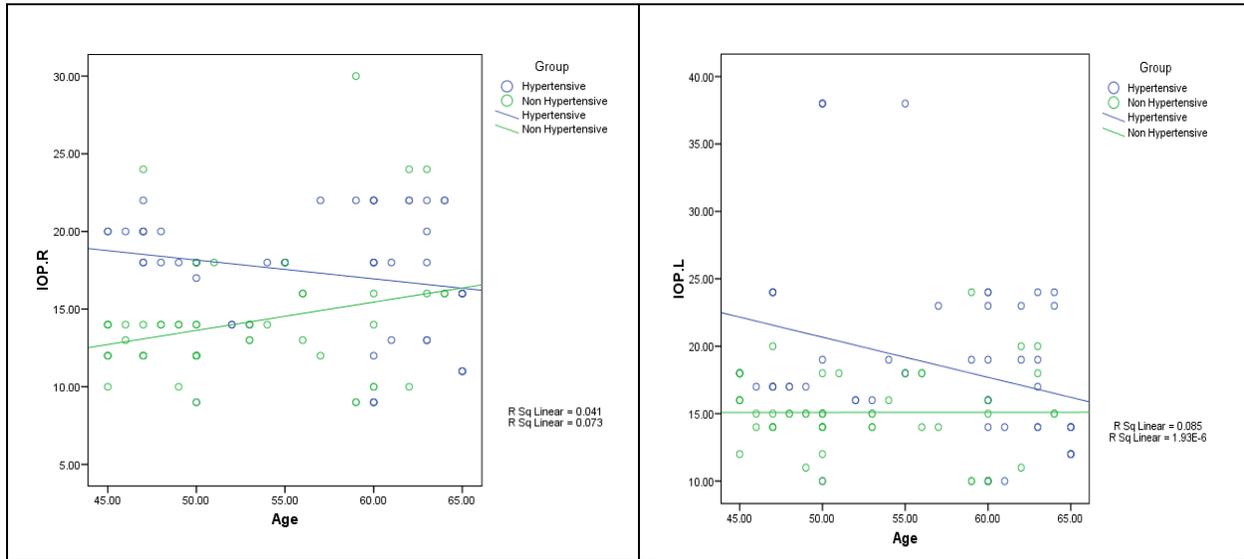
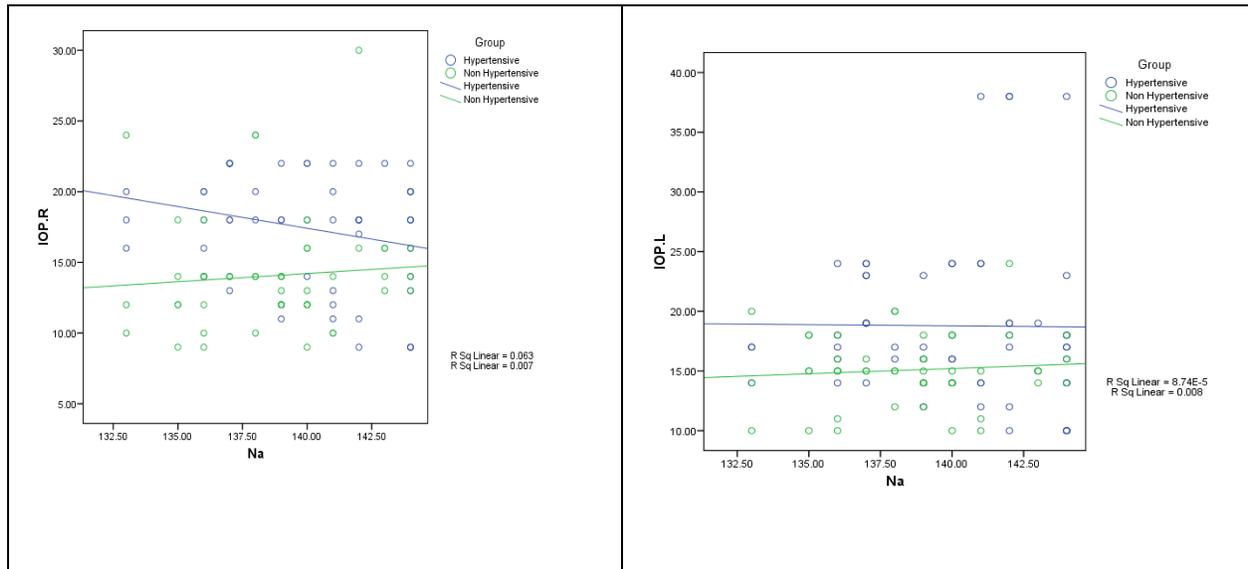


Figure 1: Correlation between age and IOP in hypertensive and non-hypertensive patients.

Figure 2: Correlation between Na and IOP in hypertensive and non-hypertensive patients.



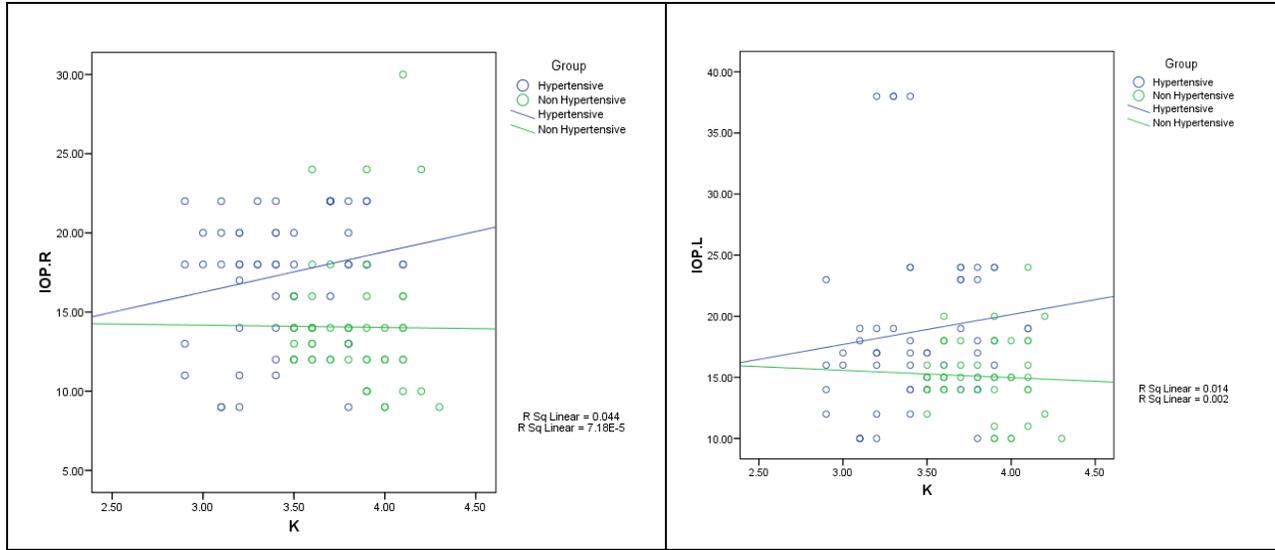


Figure 3: Correlation between K and IOP in hypertensive and non-hypertensive patients.

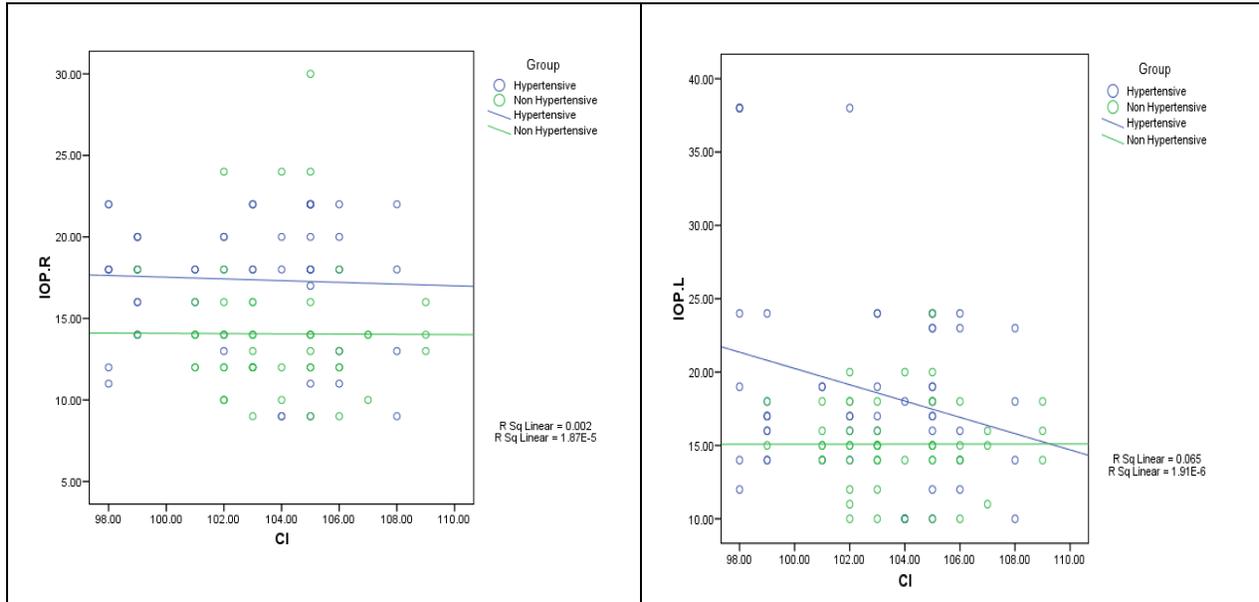


Figure 4: correlation between CI and IOP in hypertensive and non-hypertensive patients.

DISCUSSION:

Glaucoma is considered to be the foremost source of permanent blindness worldwide as per consideration of world health organization.[17] Intra ocular pressure (IOP) is linked with glaucoma and in a number of studies it has been found that blood pressure is significantly associated with IOP.[18]

Change in IOP is directly linked through adjustment in blood pressure and an increased IOP is one of the main risk factors resulting in glaucomatous neuropathy or glaucoma. As per findings of different

studies that there exist a +ve correlation among blood pressure and IOP. Klein et al. noted significant correlation between IOP and pressures of blood both systolic & diastolic. [19] Another finding showed that SBP, DBP and MAP were significantly correlated in a positively way with IOP.[20]

In this study negative weak correlation was seen between age and IOP in hypertensive and in normotensive, weak but positive correlation was seen. Among both hypertensive and normotensive correlation was not statistically significant. Age,

pulse pressure, mean arterial pressure were significantly associated with IOP as per results of an Indian study. For all these parameters a rising tendency was seen in IOP. [21]

Another Indian study compared IOP difference in postmenopausal hypertensive and normotensive women. As per their findings a significant correlation was witnessed amongst IOP and SBP and positive correlation was obtained between IOP and DBP in hypertensive postmenopausal women.[22]

Evidence which proves a direct relationship between salt consumption & blood pressure was known through randomized medical trials on intake of nutritional salt. Results of meta-analyses of altered trials in non hypertensive generally are identical to estimated derivative from follow up studies of population. The meta analyses of interventional studies have time after time revealed that K supplementation help in lowering of BP. Conversely, 24-hour urinary sodium and/or potassium excretion showed contradictory results in follow up studies. Current data does not grasp the present approval of a extensive and chaotic decrease of salt use at the level of population, though BP lowering outcome of nutritional Na⁺ constraint may be of importance in HTN patients. K⁺ supplementation in healthy persons or in HTN patients is not suggested by the existing guidelines.

Amongst the ecological aspects that have an effect on BP, dietary NaCl has been studied the most, and there is common agreement that increased NaCl eating results in increased BP. There is growing evidence that Cl⁻ may have an impact on BP regulation which might conceivably be yet more significant as that of Na⁺. Therefore, expound the function of Cl⁻ as an autonomous competitor in BP regulation [23]

In this study serum potassium and chloride was higher significantly in hypertensive when equated with normotensive. i.e. Serum-K: 3.44 vs. 3.80, p-value=0.000 & Serum-Cl: 102.64 vs. 103.70, p-value=0.05. Serum sodium was significantly higher in hypertensive patients when compared with normotensive patients. Serum-Na: 140.07 vs. 138.66, p-value=0.019. In literature no study has investigated the correlation between serum electrolytes CCT and IOP in hypertensive and normotensive. This is the first study of its kind in which this relation has been investigated. Correlation between IOP & sodium (Na⁺) was very weak for both right and left eye in hypertensive and normotensive. Similarly potassium (K⁺) and IOP was very weakly correlated with each other without any statistically significance among

hypertensive and normotensive. Chloride (Cl⁻) ion did not show any statistically significant correlation for IOP in both hypertensive and normotensive.

An Indian study also evaluated electrolyte levels in hypertensive and normotensive subjects. As per findings of the study serum sodium level was significantly elevated in hypertensive and serum potassium level was significantly reduced in hypertensive patients.²⁴ Results of our study regarding serum electrolyte level in hypertensive and normotensive are in line with the results of Indian study mentioned above. [23] A Nigerian study showed almost the same results which were in connection with our study [25]

As per results of a native study, decrease in serum sodium, potassium and calcium was detected in hypertensive as compared to control subjects.²⁶ These results are also in line and support the findings of our study regarding serum electrolyte level in hypertensive and normotensive patients & its subsequent correlation with intraocular pressure.

We concluded that among hypertensive patients serum electrolyte sodium was significantly higher while potassium and chloride was significantly lower among hypertensive patients. One interesting relationship was ever first time explored in this study between IOP and serum electrolytes. But as per findings no statistically significant correlation was seen between these parameters. Further research is needed to better understand the underlying mechanisms in between serum electrolyte effects on IOP in patients with hypertension with a large sample size.

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