

# Ocular parameters alterations after hemodialysis in patients with chronic kidney diseases

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## Abstract:

**PURPOSE:** To evaluate the effects of hemodialysis (HD) on visual acuity (VA), central corneal thickness (CCT), intraocular pressure (IOP), and macular thickness (MT) in chronic kidney disease (CKD) patients and also to investigate the relationship between the ocular parameters and blood biochemical parameters such as serum albumin, creatinine, sodium, and urea levels.

**METHODS:** A prospective cohort study including a total of 24 CKD patients of both genders (above 18 years old) undergoing HD in XXX was conducted. The participants were divided into three sub-groups based on the primary cause of renal failure, group 1: Hypertensive kidney disease, group 2: Diabetic kidney disease, group 3: Other causes. All subjects underwent full ophthalmological examinations including measurement of VA using LogMAR, IOP, CCT, and CMT. Comparisons between different ocular parameters during pre- and post-HD sessions were done using the paired *t*-test. The relationship between changes in ophthalmologic and blood biochemical parameters was calculated using Pearson correlation coefficient.

**RESULTS:** HD did not significantly alter any ocular parameter within and between CKD groups. Spherical equivalent changes were found to be significantly correlated with serum K ( $r = -0.315$ ;  $P = 0.038$ ), and IOP results were positively correlated with serum creatinine ( $r = 0.330$ ;  $P = 0.029$ ) and negatively correlated with hemoglobin ( $r = -0.349$ ;  $P = 0.020$ ). Bodyweight alterations were significantly correlated with CCT ( $r = -0.03$ ;  $P = 0.0001$ ). However, no correlation between ocular parameters and duration of HD was detected.

**CONCLUSION:** Following a single HD session, ocular parameters did not alter significantly.

## Keywords:

Chronic kidney diseases, corneal thickness, hemodialysis, macular thickness, optical coherence tomography

## INTRODUCTION

Chronic kidney disease (CKD) is defined as a persistent damage of kidney functions manifested by an abnormally high level of serum creatinine for more than 3 months or calculated glomerular filtration rate  $<60$  mL/min/1.73 m<sup>2</sup> of ultrafiltration of water and other small molecules.<sup>[1]</sup> CKD is a slow, progressive, and irreversible deterioration of renal function over a period of several years.<sup>[2,3]</sup> CKD also affects other organ systems of the body such as heart, blood vessels, eyes, peripheral nerves, and bones.<sup>[2,4]</sup> Numerous researches suggested that common risk factors such as age, hypertension, and smoking and

shared pathologic pathways including oxidative stress, inflammation, and endothelial dysfunction considerably affect the development of renal diseases and ocular diseases.<sup>[4,5]</sup> In patients with chronic renal failure, ocular involvement displays a diverse array of symptoms including optic neuropathy, retinopathy, macular edema, glaucoma, and cataracts secondary to diabetes mellitus (DM).<sup>[4,5]</sup> The ocular problems in CKD patients may occur due to uremia, abnormal electrolyte balance, fluid homeostasis, hypertension, and anemia.<sup>[5]</sup> The final outcome of disease progression in CKD patients with serious impairment of kidney functions is the end-stage renal disease (ESRD). In this stage, the patient requires renal replacement therapy; either dialysis or kidney transplant for survival.<sup>[3,6]</sup>

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Dialysis acting as an artificial kidney to compensate for kidney function is a supportive rather than curative treatment.<sup>[7]</sup> Hemodialysis (HD) and peritoneal dialysis are the two types of dialysis. Patients with CKD are usually treated via HD, which is a blood filtration mechanism comprising of two circuits—a blood circuit and a dialysis solution circuit, both these circuits meet at the dialyzer and a semi-permeable membrane separates the dialysate compartment from the blood.<sup>[8]</sup> HD eliminates excess water and metabolic wastes from the extracorporeal blood by diffusion thereby maintains the electrolyte and acid-base balance and lowers blood osmolarity.<sup>[6,9]</sup> HD is a successful and effective treatment modality for ESRD patients with both positive and negative impacts on patients. The treatment of ESRD with HD causes either exceptional ocular complaints or aggravates underlying ocular diseases.<sup>[10]</sup> Several studies revealed that HD can improve certain ocular symptoms in ESRD patients, such as improvement of best-corrected visual acuity (BCVA) and lowering of macular edema caused by diabetes.<sup>[6]</sup> Nonetheless, in the majority of the cases, the negative effects of HD on the eye of the CKD patients used to outcompete its benefits.<sup>[6]</sup>

CKD patients treated with HD exhibit a broad range of ocular manifestations, including red, dry and irritated eye, ocular pain, changes in visual acuity (VA), refractive errors (REs), elevated tear osmolarity, band keratopathy, conjunctival calcium deposits, corneal endothelium changes, and lenticular opacity.<sup>[9,11]</sup> HD induces osmotic changes in blood and extracellular fluids including both aqueous and vitreous humors leading to alterations in multiple metabolic parameters, such as blood urea, sodium, potassium, and glucose level.<sup>[12]</sup> Numerous studies revealed that fluctuations of VA, RE, central corneal thickness (CCT), intraocular pressure (IOP), and macular thickness (MT) occur as an effect of HD.<sup>[4,12]</sup> The VA of CKD patients undergoing HD, particularly the elderly patients found to be lower than their age-matched counterparts, and decreased VA often ends up with visual loss.<sup>[13]</sup> Short-term alterations in VA mostly result from quick shifts of body fluid, sudden changes in glycemic control, and retraction of macular edema, whereas long-term reduction of VA occurs due to uncontrolled hypertension and poor glycemic control.<sup>[13]</sup> The effect of HD on IOP has been noted in the literature as early as the 1960s and was a controversial subject since different studies demonstrated that IOP can increase or decrease or may remain unchanged with HD.<sup>[6,10]</sup> Various methods were employed to measure IOP and diverse theories regarding the correlation between IOP and HD have been established.<sup>[10]</sup> The impact of HD on CCT was found to be variable; some researchers detected a reduction in CCT with HD, while no change in CCT was detected by other researchers.

The aim of this study was to examine the effects of HD on different ophthalmologic parameters such as VA, IOP, CCT, and MT in CKD patients. The relationship between these ocular parameter changes with systemic hemodynamic parameters such as body weight, systolic and diastolic blood pressures (BPs) after HD was investigated. Furthermore, the association between ocular parameters and blood biochemical parameters, for example, serum albumin, urea, creatinine,

electrolytes, fasting glucose level, and hemoglobin in CKD patients undergoing HD was evaluated.

## METHODS

### Subjects

An observational prospective cohort study was conducted on a total of 24 patients, diagnosed with CKD and underwent HD in XXX. An equal number of patients from both genders (12 males and 12 females) were recruited and divided into three subgroups based on the primary cause of renal insufficiency. The subgroups included: (I) patients with hypertensive kidney disease ( $n = 10$ ), (ii) diabetic kidney disease ( $n = 7$ ), and (iii) other causes ( $n = 7$ ). Inclusion criteria were as follows: CKD participants undergoing HD with a schedule of three sessions per week for at least 3 months, VA better than 20/200. Exclusion criteria were: The presence of an ocular pathology that would interfere with retinal examination or IOP measurement and prior ocular surgery, laser therapy, or intraocular injection within 3 months of enrollment.

This study was adhered to the Declaration of Helsinki and was ethically approved by KSMC, Riyadh. A signed informed consent form was obtained from each patient before participating in the study.

### Study examination

#### Vital signs

Such as body weight and BP were measured routinely before and after HD. The change in body fluid indicated the amount of fluid removed during HD.

#### Ocular parameters

All subjects underwent full ophthalmological examination including VA, IOP, CCT, and MT measurements. Each measurement was performed within an hour before and after completing a single HD session. Among 24 participants, a total of 48 eyes were examined for SE, VA, IOP, CCT, and 38 eyes for MT (10 eyes were excluded due to poor image quality and optical coherence tomography [OCT] images artifacts).

BCVA was examined using a standard vision chart and the logarithmic minimum angle of resolution (log MAR) was recorded. IOP was measured using NIDEK TonometerTonoref II. The IOP was calculated by dividing the amount of air pressure into the area of applanated surface. The device increased the air pressure puffed onto the cornea in proportion to time. The shape of the cornea changed gradually in the order of convex surface → applanated surface → concave surface. This change could be optically detected, and the device calculated the time required to make the pressed area flat after air was puffed on it and finally the IOP was obtained.<sup>[14]</sup> Measurement of CCT was done with NIDEK Specular Microscope CEM-530, which is a noncontact ophthalmic microscope with optical pachymeter and camera intended for examination of the corneal endothelium and for the measurement of thickness of the cornea. It has auto-tracking and auto-shooting functions. High magnification image capture of the endothelium enabled the observation of the size and shape of cells. Information

such as the corneal endothelial cell density, the coefficient of variation of corneal endothelial cell area, and % hexagonality of cells can be analyzed through the captured images.<sup>[15]</sup> ZEISS CIRRUS™ photo 800°CT (Carl Zeiss Meditec, Inc., Dublin CA, United States), a noninvasive spectral-domain OCT was used to measure central MT. It used to combine both nonmydriatic and mydriatic fundus imaging and OCT scan and allowed *in vivo* viewing, axial cross-sectional, three-dimensional imaging, and measurement of posterior ocular structures, including retina, retinal nerve fiber layer, macula, and optic disc.<sup>[16]</sup>

**Blood examination**

Blood reports including serum albumin, urea, creatinine, sodium, potassium, fasting glucose, and hemoglobin levels were collected from the patient’s datasheet before HD.

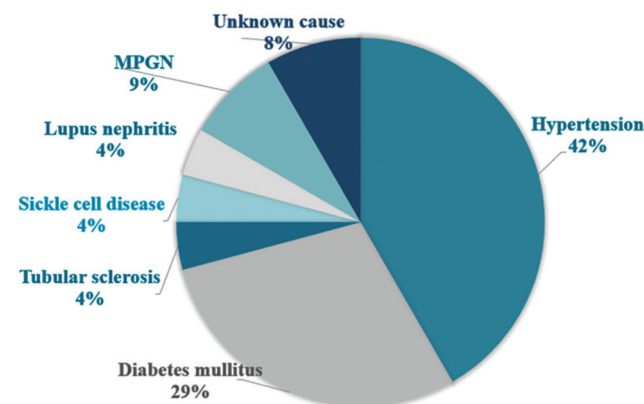
**Statistical analysis**

Comparisons between SE, VA, IOP, CCT, and MT during pre- and post-HD sessions were done using the paired *t*-test. A Pearson correlation test was performed and the Pearson correlation coefficient was calculated to examine the relationships between changes in ophthalmologic and blood biochemical parameters. All data analysis was performed using Using Statistical Package for the Social Sciences SPSS software (Version 24, IBM Corp., Armonk, NY, USA). Normality was checked using the Kolmogorov–Smirnov test. All data are presented as the means ± standard deviation (means ± standard deviation). A *P* < 0.05 was considered statistically significant.

**RESULTS**

**Demographic characteristics**

A total of 24 patients were enrolled in this study. Average patient age was 46.9 ± 11.7 years. The patients were undergoing HD for a mean period of 9 ± 6.338 years. Table 1 shows demographic data of the study participants. The probable causes of CKD included hypertension (*n* = 10 or 42%), DM (*n* = 7 or 29%), tubular sclerosis (*n* = 1 or 4%), sickle cell disease (*n* = 1 or 4%), lupus nephritis (*n* = 1 or 4%), membranoproliferative glomerulonephritis (*n* = 2 or 8%), and unknown causes (*n* = 2 or 8%) as shown in Figure 1.



**Figure 1:** Causes of chronic kidney disease

**Effects of hemodialysis on systemic and different ocular parameters**

The change in the body weight of the patients before and after HD session was highly statistically significant (*P* < 0.000). The systolic and diastolic BPs did not show significant changes (*P* = 0.071, *P* = 0.097) following a HD session [Table 2]. Ocular parameters of all CKD patients didn’t change significantly after a single HD session; VA (pre-HD 0.39 ± 0.27, post-HD 0.43 ± 0.46, *P* = 0.495), SE (pre-HD 0.36 ± 2.88, post-HD 0.47 ± 2.9, *P* = 0.158), IOP (pre-HD 15.5 ± 3.5, post-HD 15.3 ± 3.9, *P* = 0.526), CCT (pre-HD 559.8 ± 37.8, post-HD 560.2 ± 37.7, *P* = 0.660), and MT (pre-HD 205.13 ± 33.3, post-HD 210.47 ± 33.12, *P* = 0.315) as summarized in Table 2. In addition, HD did not change ocular parameters significantly in patients with different CKD subtypes within each group and between groups [Table 3].

**Correlations between ocular and systemic parameters**

There was a highly significant correlation between CCT and body weight (*r* = -0.03; *P* = 0.0001). Furthermore, all ocular parameter changes were significantly correlated with the systolic and diastolic BPs [Table 4].

**Table 1: Demographic data**

Demographic Data	n
Total participants	24
Gender (male/female)	12/12
Age (years)	46.9±11.7
Duration of HD (years)	9±6.338

HD: Hemodialysis

**Table 2: Effect of hemodialysis on ocular and systemic parameters (paired t-test) (n=24)**

	Pre-HD	Post-HD	<i>P</i>
VA	0.39±0.27	0.43±0.46	0.495
SE	0.36±2.88	0.47±2.9	0.158
IOP	15.5±3.5	15.3±3.9	0.526
CCT	559.8±37.8	560.2±37.7	0.66
MT	205.13±33.3	210.47±33.12	0.315
Body weight (kg)	68.66±16.0	65.5±16.1	0.000**
Systolic BP (mmHg)	151.16±20.6	140.79±22.4	0.071
Diastolic BP (mmHg)	89.16±13.46	80.6±22.8	0.097

HD: Hemodialysis, VA: Visual acuity, SE: Spherical equivalent, IOP: Intraocular pressure, CCT: Central corneal thickness, MT: Macular thickness, BP: Blood pressure, \*Significant, \*\*Highly Significant

**Table 3: Changes in ocular parameters with hemodialysis between groups (one-way ANOVA)**

	HTN group	DM group	Other causes	<i>P</i>
SE	-0.09±0.48	0.13±0.4	0.14±0.7	0.95
VA	-0.13±0.6	0.02±0.06	0.03±0.1	0.42
IOP	-0.3±1.4	0.6±2.2	0.49±2.2	0.345
CCT	1.2±4.9	-0.08±5.7	-2.86±5.8	0.112
CMT	-1.167±3.7	-1.08±7.1	-12.9±12.1	0.504

VA: Visual acuity, SE: Spherical equivalent, IOP: Intraocular pressure, CCT: Central corneal thickness, CMT: Central macular thickness, HTN: Hypertension, DM: Diabetes mellitus

### Correlations between ocular and blood biochemical parameters

SE changes were significantly correlated with serum K ( $r = -0.315$ ;  $P = 0.038$ ) and IOP measurement was positively correlated with serum creatinine ( $r = 0.330$ ;  $P = 0.029$ ) and negatively correlated with hemoglobin ( $r = -0.349$ ;  $P = 0.02$ ) [Table 5].

### Correlation between duration of hemodialysis and ocular parameter changes

All the ocular parameters (VA, SE, IOP, CCT, and MT) did not show considerable correlation with the duration of HD ( $r = 0.140$ ;  $P = 0.366$ ), ( $r = -0.098$ ;  $P = 0.528$ ), ( $r = -0.045$ ;  $P = 0.773$ ), ( $r = -0.211$ ;  $P = 0.170$ ), ( $r = -0.006$ ;  $P = 0.969$ ), respectively [Table 6].

## DISCUSSION

The patients suffering from CKD show systemic accumulation of body fluid. HD is an efficient treatment approach for CKD patients.<sup>[17]</sup> During HD, excess fluid and metabolic wastes are removed from plasma by ultrafiltration, causing blood volume depletion and lowering of solute concentration and crystal osmotic pressure.<sup>[6]</sup> The diminution of blood volume is equilibrated by vascular refilling from the interstitial and intracellular space.<sup>[18]</sup> HD technique affects systemic and ocular parameters in many patients.<sup>[13,17]</sup> HD usually alters aqueous and vitreous humors leading to changes in metabolic parameters such as serum urea, creatinine, sodium, potassium, and glucose levels and this can result in the variations of VA, IOP, and retinal thickness.<sup>[12]</sup> The current study aimed to evaluate the effect of HD on selected ocular parameters (VA, SE, IOP, and CCT, CMT) in 24 CKD patients and detected that a single HD session did not significantly alter any ocular parameter within and between CKD groups.

HD typically reduces systemic parameters, such as body weight, systemic and diastolic BPs, and serum osmolarity.<sup>[17]</sup> During a single HD session, 2–4 L of body fluid is eliminated, which is possibly responsible for lowering body weight and dialysis-induced hypotension. Elbay *et al.* observed a reduction in mean systolic and diastolic BPs and body weight after HD.<sup>[17]</sup> Concomitantly, the present study determined a highly significant reduction in post-HD body weight. Both systolic and diastolic BPs show somewhat reduction after HD; however, the reduction was not statistically significant.

In this study, no significant change in ophthalmologic parameters such as BCVA and SE were observed after a single HD session. This was in accordance with the finding of Chelala *et al.* who conducted a study on 49 CKD patients with a mean age of  $68.0 \pm 12.7$  years and found no significant change in BCVA after HD.<sup>[12]</sup> Zhang *et al.* also could not detect a significant change in BCVA before and after HD.<sup>[18]</sup> However, Ghasemi *et al.* observed that mean BCVA and overall mean SE differed significantly between pre- and post-HD sessions and suggested this change could be associated with increased

**Table 4: Correlations between ocular and systemic parameters (n=24)**

	Mean	VA	SE	IOP	CCT	CMT
Weight (kg)						
<i>r</i>	3.16±1.08	0.09	0.06	0.4	-0.03	0.3
<i>P</i>		1.65	3.31	4.33	0.0001**	0.08
Systolic BP (mmHg)						
<i>r</i>	10.4±26.6	0.36	0.2	-0.13	-0.2	-0.2
<i>P</i>		0.01*	0.01*	0.02*	0.01*	0.02*
Diastolic BP (mmHg)						
<i>r</i>	8.6±23.95	-0.02	0.14	0.2	0.2	0.18
<i>P</i>		0.02*	0.01*	0.02*	0.01*	0.004*

VA: Visual acuity, SE: Spherical equivalent, IOP: Intraocular pressure, CCT: Central corneal thickness, CMT: Central macular thickness, BP: Blood pressure, \*Significant, \*\*Highly Significant

**Table 5: Correlations between ocular and blood biochemical parameters**

	HTN group	DM group	Other causes	<i>P</i>
SE	-0.09±0.48	0.13±0.4	0.14±0.7	0.95
VA	-0.13±0.6	0.02±0.06	0.03±0.1	0.42
IOP	-0.3±1.4	0.6±2.2	0.49±2.2	0.345
CCT	1.2±4.9	-0.08±5.7	-2.86±5.8	0.112
CMT	-1.167±3.7	-1.08±7.1	-12.9±12.1	0.504

VA: Visual acuity, SE: Spherical equivalent, IOP: Intraocular pressure, CCT: Central corneal thickness, CMT: Central macular thickness, HTN: Hypertension, DM: Diabetes mellitus

**Table 6: Correlation between duration of the hemodialysis and ocular parameters changes (n=24)**

	Mean	VA	SE	IOP	CCT	CMT
Weight (kg)						
<i>r</i>	3.16±1.08	0.09	0.06	0.4	-0.03	0.3
<i>P</i>		1.65	3.31	4.33	0.0001**	0.08
Systolic BP (mmHg)						
<i>r</i>	10.4±26.6	0.36	0.2	-0.13	-0.2	-0.2
<i>P</i>		0.01*	0.01*	0.02*	0.01*	0.02*
Diastolic BP (mmHg)						
<i>r</i>	8.6±23.95	-0.02	0.14	0.2	0.2	0.18
<i>P</i>		0.02*	0.01*	0.02*	0.01*	0.004*

VA: Visual acuity, SE: Spherical equivalent, IOP: Intraocular pressure, CCT: Central corneal thickness, CMT: Central macular thickness, BP: Blood pressure, \*Significant, \*\*Highly Significant

blood glucose level.<sup>[13]</sup> Likewise, Jung *et al.* (2013) observed a mild reduction in the BCVA following HD.<sup>[11]</sup> Normally, VA depends on the health of the cornea, lens, retina, and axial length. HD patients may suffer from acute or chronic vision changes. Although acute changes result from the alterations in ocular parameters during HD, the chronic changes usually occur due to eye disease rather than renal insufficiency.<sup>[12]</sup>

HD with a high ultrafiltration volume affects IOP and this has been a topic of research for many decades.<sup>[19,20]</sup> A multitude of studies had reported changes in IOP following HD.



Nevertheless, the results of these studies are conflicting with varied conclusions.<sup>[6,20]</sup> Some studies reported an increase in IOP during HD and proposed that elevated IOP resulted from osmotic disequilibrium between serum and aqueous humor induced by HD procedure, particularly when its outflow system was compromised. In contrast, a considerable reduction in post-HD IOP was determined by several studies and the attributing factor was anticipated to be enhanced plasma colloidal pressure due to fluid removal during the HD session.<sup>[20]</sup> In addition, some of the recent investigations failed to establish any substantial change in IOP measurements after HD. The researchers proposed that advanced dialysis technique involving high-flux hemofiltration and improved urea control led to higher osmotic balance and inhibited IOP change.<sup>[20]</sup> In general, the measurement technique and the anterior chamber angle contribute to the post-HD IOP changes. Lowering in IOP was observed when Goldmann tonometer was used, whereas elevated IOP was observed with NCT since, in NCT, the IOP rises in a narrow and obstructive anterior chamber angle.<sup>[6]</sup> In fact, in HD patients with narrow angles, neovascular glaucoma, or exfoliative glaucoma, a sharp rise in IOP was observed after HD because a sudden lowering in plasma osmolarity during HD creates an osmolar gradient between plasma and ocular tissue leading to a shift of fluid into the ocular tissue.<sup>[17]</sup> Elbay *et al.* noticed a significant increase in mean IOP during the second hour of HD; however, after HD, IOP decreased to a value somewhat similar to the pre-HD value.<sup>[17]</sup> Ulas *et al.*, Caglayan *et al.*, and Chelala *et al.* detected a sharp decline in IOP after HD in CKD patients and also a strong correlation between IOP and serum albumin levels and weight changes was observed.<sup>[12,19,21]</sup> On the contrary, the current study could not spot any significant IOP change after HD, irrespective of the etiology of CKD. Unlike, the findings of Chelala (2015), no correlation between IOP and body weight and serum albumin was observed. Conversely, IOP was found to be associated with creatinine level.

A small number of studies evaluated the value of CCT in CKD patients undergoing HD. Similar to IOP, the effect of HD on CCT is somewhat ambiguous.<sup>[4]</sup> Caglayan *et al.* noticed a reduction in CCT after HD and proposed that total body fluid loss following HD resulted in an efflux of water from the eye to the plasma leading to a diminution in the CCT value.<sup>[21]</sup> In contrast, Elbay *et al.* demonstrated an increased post-HD CCT value and inferred that redistribution of fluid led to elevated CCT and CCT was also correlated with IOP.<sup>[11,17]</sup> The present study could not figure out any change in CCT after HD. The dissimilarities between our finding and other studies could be attributed to different study populations and CCT measurement techniques.<sup>[4]</sup>

An increase in post-HD choroidal thickness in CKD patients was reported in a recent study and assumed to be linked with choroidal autoregulatory control of ocular hemodynamics. Choroidal autoregulation is largely affected by its highly vascularized composition (9F). Yang *et al.* Ulas *et al.* and Kal *et al.* alternatively reported a considerable decrease

in choroidal thickness after HD and suggested that the elimination of intravascular and interstitial fluid might lower choroidal thickness.<sup>[9,19,22]</sup> Improvement in MT after HD had been observed in previous studies,<sup>[12]</sup> which could be due to retinal autoregulation system. Visual impairment often occurs because of retinal vascular leakage or ischemia in diabetes.<sup>[13]</sup> Macula and fovea play a critical role in the central vision. The most critical vision-threatening findings occur in the posterior segment.<sup>[3]</sup> Yang *et al.* could not detect any change in central MT and volume,<sup>[9]</sup> which was in agreement with the measurement of posterior segment parameters in this study; yet they noticed a reduction in foveal thickness and macular volume in diabetic group compared to the non-diabetic group and that was not observed in our study.<sup>[9]</sup> Analogous to this study, Jung *et al.* demonstrated a significant decrease in central subfoveal thickness of approximately 7  $\mu\text{m}$ , which is independent of mean dialysis duration.<sup>[11]</sup> The change in HD conditions (bath temperature and conductivity) affecting foveal retinal thickness was also reported by Auyanet *et al.*<sup>[9,23]</sup>

In the present study, the participants were divided into three subgroups, based on the CKD etiology and the selected ophthalmologic parameters were detected and compared in different subgroups. Although some differences in these parameters were noticed between different subgroups, the differences were not statistically significant, indicating that the changes might be due to HD, rather than CKD etiology. The association between different ocular parameters and blood biochemical parameters was evaluated. No significant relationship was observed between the majority of the ocular parameters and blood parameters, especially albumin, urea, serum, and fasting glucose. A considerable positive correlation between IOP and creatinine and a negative correlation with hemoglobin was noticed. A strong correlation was spotted between SE and serum K. All ocular parameters were remarkably correlated with both systolic and diastolic BPs. Conversely, no significant correlation was identified between ocular parameters and duration of HD, denoting that the duration of HD may not affect ocular parameters. However, further studies are required to support this finding.

### Strength and limitations of this study

The main strength of this study is that this is probably the first study in Saudi Arabia investigating the effect of HD on ocular parameters in CKD patients. The incidence and prevalence of CKD are rising in Saudi Arabia over the last three decades and according to the annual report of the Saudi Center for Organ Transplantation, the incidence of dialysis in Saudi Arabia was about 136 new cases per million population (pmp), which is comparable to 585 pmp in Europe and 360 pmp in the United States.<sup>[24,25]</sup> To the best of our knowledge, till date no research studying the effect of HD on ocular parameter changes in CKD patients among the Saudi population is known.

The present study has several limitations. Firstly, the sample size is quite small, due to which it is not possible to apply the study results to all HD patients. Hence, it is important

to re-evaluate the results of this study with a larger sample size. Second, this study did not consider controlling certain activities of the participants, such as reading or watching television during the HD session, which may have impacted the ophthalmologic parameters. Finally, no control group was included in this study.

## CONCLUSION

The CKD patients undergoing HD may be at increased risk of developing vision-threatening complications. Nephrologists in the HD unit and ophthalmologists must be aware of symptoms of visual abnormalities. Overall, the present study was unable to detect significant alterations of ocular parameters following a single HD session in CKD patients. Probably, it is rational to estimate the changes during HD in addition to pre and post-HD sessions in future studies. Besides, large-scale randomized studies with more systemic parameters might be beneficial to assess the effects of HD on ocular parameters and their correlations with systemic and blood biochemical parameters. In addition, for the superior quality of ocular examinations, it is worthwhile to conduct the ophthalmic assessment on a nondialysis day. It is advisable for CKD patients to undergo regular and annual ophthalmologic examinations to monitor any visual abnormalities and the patients must be made aware of ocular complications related to CKD. Proper knowledge of the common ocular problems encountered by HD patients may result in rapid diagnosis and accurate therapeutic interventions thereby inhibiting vision loss.

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## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Chertow GM, Burdick E, Honour M, Bonventre JV, Bates DW. Acute kidney injury, mortality, length of stay, and costs in hospitalized patients. *J Am Soc Nephrol* 2005;16:3365-70.
- Wang L, Yin G, Yu Z, Chen N, Wang D. Effect of hemodialysis on eye coats, axial length, and ocular perfusion pressure in patients with chronic renal failure. *J Ophthalmol* 2018;2018:3105138.
- Malleswari, Rahmathunnisa, Irshad. Eye findings in chronic renal failure patients undergoing hemodialysis. *Int J Contemp Med Res* 2016;3:1912-4.
- Caliskan S, Celikay O, Bicer T, Ayli MD, Gurdal C. Effect of hemodialysis on intraocular lens power calculation. *Ren Fail* 2016;38:209-13.
- Theodossiadis PG, Theodoropoulou S, Neamonitou G, Grigoropoulos V, Liarakos V, Triantou E, *et al.* Hemodialysis-induced alterations in macular thickness measured by optical coherence tomography in diabetic patients with end-stage renal disease. *Ophthalmologica* 2012;227:90-4.
- Chen H, Zhang X, Shen X. Ocular changes during hemodialysis in patients with end-stage renal disease. *BMC Ophthalmol* 2018;18:208.
- Ma H, Cherng S, Yang Y. Dialysis and its application. *N Y Sci J* 2009;2:91-6.
- Agarwal AK, Ahmad S, Allon M, John T, Peter G, Todd S. *Handbook of Dialysis*. 5<sup>th</sup> ed. United States: Wolters Kluwer Health; 2007.
- Yang SJ, Han YH, Song GI, Lee CH, Sohn SW. Changes of choroidal thickness, intraocular pressure and other optical coherence tomographic parameters after haemodialysis. *Clin Exp Optom* 2013;96:494-9.
- Mullaem G, Rosner MH. Ocular problems in the patient with end-stage renal disease. *Semin Dial* 2012;25:403-7.
- Jung JW, Yoon MH, Lee SW, Chin HS. Effect of hemodialysis (HD) on intraocular pressure, ocular surface, and macular changes in patients with chronic renal failure. *Graefes Arch Clin Exp Ophthalmol* 2013;251:153-62.
- Chelala E, Dirani A, Fadlallah A, Slim E, Abdelmassih Y, Fakhoury H, *et al.* Effect of hemodialysis on visual acuity, intraocular pressure, and macular thickness in patients with chronic kidney disease. *Clin Ophthalmol* 2015;9:109-14.
- Ghasemi H, Afshar R, Zerfatjou N, Abdi S, Davati A, Khorsand Askari M, *et al.* Impact of hemodialysis on visual parameters in patients with end-stage renal disease. *Iran J Kidney Dis* 2012;6:457-63.
- Ref A. Auto Ref/Kerato/Tonometer, Tonoref II: Operator's Manual, Original Instructions. Available from: [https://revolutionehr.com/pms/resources/RevHelp/Nidek-TONOREF2\\_Refractor-MultiFunction-OperatorsManual.pdf](https://revolutionehr.com/pms/resources/RevHelp/Nidek-TONOREF2_Refractor-MultiFunction-OperatorsManual.pdf). [Last accessed on 2019 Apr 10].
- Dasilveira R. Specular microscopy. *Mycol Res* 2002;106:1323-30.
- CIRRUS Photo, Certainty Meets Versatility, Carl Zeiss Meditec AG, Germany. Available from: [https://www.amedeolucente.it/pdf/cirrusphoto\\_komplett\\_optimiert.pdf](https://www.amedeolucente.it/pdf/cirrusphoto_komplett_optimiert.pdf). [Last accessed on 2019 Apr 10].
- Elbay A, Altinisik M, Dinciyildiz A, Kutluturk I, Canan J, Akkan U, *et al.* Are the effects of hemodialysis on ocular parameters similar during and after a hemodialysis session? *Arq Bras Oftalmol* 2017;80:290-5.
- Zhang Y, Weng H, Li Q, Wang Z. Changes in retina and choroid after haemodialysis assessed using optical coherence tomography angiography. *Clin Exp Optom* 2018;101:674-9.
- Ulas F, Dogan U, Keles A, Ertlav M, Tekce H, Celebi S. Evaluation of choroidal and retinal thickness measurements using optical coherence tomography in non-diabetic haemodialysis patients. *Int Ophthalmol* 2013;33:533-9.
- Liakopoulos V, Demirtzi P, Mikropoulos DG, Leivaditis K, Dounousi E, Konstas AG. Intraocular pressure changes during hemodialysis. *Int Urol Nephrol* 2015;47:1685-90.
- Caglayan M, Kosekahya P, Takmaz T, Altunoglu A, Ayan B, Atilgan CU, *et al.* Effects of hemodialysis on corneal and anterior chamber morphometry and intraocular pressure in patients with end-stage renal disease. *Arq Bras Oftalmol* 2017;80:176-80.
- Kal A, Kal O, Eroglu FC, Öner O, Kucukerdonmez C, Yilmaz G. Evaluation of choroidal and retinal thickness measurements in adult hemodialysis patients using spectral-domain optical coherence tomography. *Arq Bras Oftalmol* 2016;79:229-32.
- Auyanet I, Rodríguez LJ, Bosch E, Sánchez AY, Esparza N, Lago MM, *et al.* Measurement of foveal thickness by optical coherence tomography in adult haemodialysis patients with diabetic nephropathy. *Nefrologia* 2011;31:66-9.
- Al-Sayyari AA, Shaheen FA. End stage chronic kidney disease in Saudi Arabia. A rapidly changing scene. *Saudi Med J* 2011;32:339-46.
- Alsawaia AO, Farag YM, Al Sayyari AA, Mousa D, Alhejaili F, Al-Harbi A, *et al.* Epidemiology of chronic kidney disease in the Kingdom of Saudi Arabia (SEEK-Saudi investigators)-A pilot study. *Saudi J Kidney Dis Transpl* 2010;21:1066-72.