Effect of Hemodialysis on Intraocular Pressure and Central Corneal Thickness in Patients With Chronic Renal Failure

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Abstract

Background: This study evaluated short-term changes in intraocular pressure (IOP) and corneal thickness (CCT) following haemodialysis (HD) in chronic renal failure (CRF) patients. Methods: We studied 34 eyes of 34 patients with CRF undergoing HD. Patients included in the study were classified into two subgroups: with diabetes mellitus (DM, group 1) and without diabetes mellitus (non-DM, group 2). All patients underwent a detailed ophthalmological examination including CCT and IOP before and after the HD session. Total body weight and body volume loss after haemodialysis were also measured. Results: The sex distribution of patients were as 22 females (64.7%) and 12 males (35.3%). The DM group was comprised of 19 patients (55.9%), and the non-DM had 15 patients (44.1%). The mean age was 60.3 ± 17.2 (range 21–88) years, and the dialysis time was 51.4 ± 38.5 (range 5–132) months. The mean IOP change after HD decreased from 15.88±2.37 to 14.11±2.02 mmHg (95% CI, 1.40–2.11; $p < 0.001$). The mean CCT decreased from 554.88±14.27 to 550.52±13.67 μm. (95% CI, 1.97–4.08; P = $p < 0.001$). The loss in body volume was positively correlated with a decrease in IOP ($r = 0.737$, $p < 0.001$) and CCT ($r = 0.784$, $p < 0.001$). Conclusions: Patients at high risk of being affected by changes in intraocular pressure , may be adversely affected by IOP and CCT changes following HD. Therefore, a detailed ophthalmologic examination should be performed to take preventive measures for at-risk patients before and after HD.

Background

During haemodialysis (HD), diffusion eliminates osmotically active materials, resulting in fluid loss of the body and reduced blood osmolarity [1]. Consequently, these changes can affect ocular parameters such as central corneal thickness (CTT) and intraocular pressure (IOP).

Both the uremic state and dialysis procedure itself can cause several ocular abnormalities in patients with chronic renal failure (CRF) undergoing HD [2, 3]. CRF patients treated with HD have various ophthalmologic findings such as increased tear osmolarity, dry eyes and corneal endothelium changes [4, 5]. In CRF patients, posterior segment findings such as retinopathy and neuropathy may be seen depending on both HT and DM [6, 7].

Systemic hemodynamic parameters, as well as eye fluid volume and composition, can change with HD. Many studies examining the anterior and posterior segment showed significant changes in IOP and CCT [8–12]. Given the contradictory reports of HD affecting IOP, precise and mechanistic insights of HD on IOP are not well-established [11, 13, 14]. If the CCT values are above or below normal, they lead to an incorrect evaluation of IOP values.

Therefore, this study aimed to evaluate IOP changes after HD sessions. We also aim to demonstrate the possible association between IOP, CRF, total body volume losses, and serum osmolality. We observed short-term changes in central corneal thickness (CCT) and IOP before and after HD.

Methods

We performed this prospective cross-sectional study in the ophthalmology outpatient clinic of our hospital. We performed the study after the approval of the Ethics Committee of Gazi Yasargil Training and Research Hospital (decision # 2018/84). And our study was performed according to the Declaration of Helsinki. We received written informed consent from all patiens before including in the study.

In total, we examined the right eyes of 34 chronic renal failure patients undergoing HD in the Dialysis Unit of our hospital. Patients included in the study were classified into two subgroups: group 1 (with DM, 15 patients) and group 2 (non-DM, 19 patients). All subjects underwent haemodialysis sessions three to four times a week on average using high performance dialysis devices with a blood circulation rate of 250 ml / minutes. Patients who had visual acuity over 20/200 and had received HD treatment in the morning sessions for at least three months were included in this study. Patients with corneal haze, history of ocular surgery in the last three months, history of glaucoma, laser photocoagulation, or ocular trauma were excluded from the study.

All patients underwent a detailed ophthalmological examination including CCT and IOP before and after the HD session. Anterior and posterior segments were examined with slit-lamp biomicroscopy. Best-corrected visual acuity was measured with a Snellen chart. IOP was measured by Goldmann applanation tonometer, while CCT was measured by ultrasonic pachymetry (Compact Touch, Quantel Medical, France).

Each measurement was made in the right eye of each patient within an hour before beginning HD and within one hour after completing a single HD session. To reduce the effects of corneal diurnal variation, we only included morning session HD patients. CCT was obtained by calculating the average of three measurements taken from the central cornea. Body weight was measured before and after HD, and volume loss after HD was calculated.

Statistical analysis

We performed all statistical analyses using SPSS software (Version 22.0; SPSS Inc., Chicago, IL, USA). A paired T test was used to evaluate IOP and CCT changes before and after HD. Pearson correlation test was performed to evaluate the correlation between total body volume loss and IOP decrease and CCT decrease. Mann-Whitney test was performed to compare the groups (DM and non-DM). Only the right eyes were analysed. All results were accepted as statistically significant if p value is <0.05.

Results

We examined thirty-four patients in this study; 22 (64.7%) were females and 12 (35.3%) were males. Nineteen of the patients (55.9%) had DM, while 15 (44.1%) did not. The mean age was 60.3 ± 17.2 (range 21–88) years.

Mean dialysis time was 51.4 ± 38.5 (range 5–132) months. It was determined that IOP, CCT and body volume reduction were normally distributed ($p > 0.05$). Mean weight loss (kg) after HD was 1.8 ± 0.8

(0.20–3.70) kg (95% CI, 1.53–2.09; $p < 0.001$). The mean body volume loss after HD was 2138.2 ± 921.7 (range 300–4000) (95% CI, 1816.6–2459.8; $p < 0.001$). (Table 1)

The mean IOP decreased by 1.76±1.01 mmHg after HD, from 15.88±2.37 to 14.11±2.02 mmHg (95% CI, 1.40–2.11; $p < 0.001$). The mean CCT decreased significantly from 554.88±14.27 to 550.52±13.67 μm (95% CI, 1.97–4.08; $p < 0.001$). (Table 2)

The decreases in IOP and CCT were similar in both sexes and subgroups ($p > 0.05$). Body volume loss was significantly correlated with decreased IOP ($r = 0.73$, *p* □ 0.05, Fig. 1) and decreased CCT (r = 0.78, p □ 0.05, Fig. 2). While decreased CCT was positively correlated with the presence of additional disease ($r = 0.29$, p □ 0.87), decreased IOP was negatively correlated with the presence of additional disease ($r = -0.90$, p □ 0.61).

Discussion

We found that the IOP and CCT decreased significantly following haemodialysis. Also, mean body volume and weight decreased significantly after haemodialysis.

The kidneys are important to homeostasis as they protect the body fluid electrolyte balance. Therefore, hemodynamic parameters and fluid electrolyte balance are disturbed when kidney failure occurs. We attempt to improve these parameters with haemodialysis. HD may cause changes in plasma colloid osmotic pressure and serum osmolarity, which may affect many systemic parameters [15].

There are many studies showing that haemodialysis either increases, decreases, or does not change IOP and/or CCT [9, 16–21]. The possible causes of lower IOP and CCT after HD are: correcting the amount of excessively accumulated and abnormally dispersed fluid in the body, or increased plasma colloid osmotic pressure. Due to increased plasma colloid pressure, the liquid can flow from the aqueous humour to the plasma. This may lead to a decrease in both IOP and CCT. Some studies have reported that intraocular pressure increases due to increased fluid flow from serum to aqueous humour and impaired fluid output in the trabecular network during HD [15, 22, 23].

In our study, after HD, we found a significant decrease in CCT from 554.88±14.27 to 550.52±13.67 (95% CI, 1.9744.08; $p < 0.001$). Similar to our study, although there are studies reporting a decrease in CCT [24], there are studies reporting that there is no change in CCT [25].

After HD, we found a significant decrease in IOP from 15.88±2.37 to 14.11±2.02mmHg (95% CI, 1.40–2.11; $p < 0.001$) as in some previous studies [19]. However, some studies have also reported that IOP has increased or remained unchanged after HD [21, 23].

Also in our study, we detected body volume loss was significantly correlated with decreased IOP (r = 0.73, p □ 0.05) and decreased CCT (r = 0.78, p □ 0.05). We found that CCT and IOP decrease did not differ according to gender or DM ($p > 0.05$). Similar to many studies in our study, we measured IOP with applanation tonometry which is the best method. This tonometer is affected by CCT and needs to be corrected according to CCT [26, 27].

In summary, we found that both IOP and CCT significantly and independently decreased regardless of DM and gender after the HD sessions. Therefore, after HD sessions, caution should be exercised in the evaluation of both IOP values and CCT values in patients with CRF. This is important for regulating intraocular pressure in patients with a high risk of being affected by changes in intraocular pressure. [27–29].

Conclusions

While HD corrects the body’s fluid electrolyte imbalance due to kidney failure, many ocular parameters such as IOP and CCT, may change quickly due to changes in the aqueous humour. However, many studies report contradictory results for both IOP changes and CCT changes. Therefore, more studies are needed to understand the importance of IOP changes and CCT changes in CRF patients.

Abbreviations

IOP: Intraocular pressure

CCT: Central corneal thickness

HD: Haemodialysis

CRF: Chronic renal failure

DM: Diabetes Mellitus

Declarations

Ethics approval and consent to participate

The study protocol was approved by the ethical research committee of Gazi Yasargil Training and Research Hospital (decision # 2018/84). Informed consent was obtained from all individual participants included in the study. The ethical principles outlined in the Declaration of Helsinki and those of Good Clinical Practice were followed.

Consent for publication

Not applicable in this study.

Availability of data and materials

All data generated and analyzed during this study were included in this manuscript.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SE designed this study. SE and MG collected and analyzed the data and generated the figures. SE and SE involved with the manuscript development and proofreading. SE reviewed and revised the manuscript. SE and MG approved the final version of the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1. Demographic data of the patients

Characteristics	
Age (years)	60,38± 17,20 (21-88)
Gender (n, %) · Female · Male	22 (64.70%) 12 (35.29%)
Presence of DM (n, %) · DM · Non-DM	15 (44.12%) 19 (55.88%)
Hemodialysis time (month)	51.41±38.52 (5-132)
Body volume loss after HD (cc)	2138.23 ± 921.79 (300-4000)
Weight loss after HD (kg)	1.81±0.80 (0.20-3.70)

Table 2. The IOP and CCT measurements before and after HD.

Parameters	Before HD	After HD	Decline
Intraocular pressure (mmHg)	15.88±2.37	14.11±2.02	1.76±1.01
Central corneal thickness (μm)	554.88±14.27	550.52±13.67	4.35±2.22

Figures

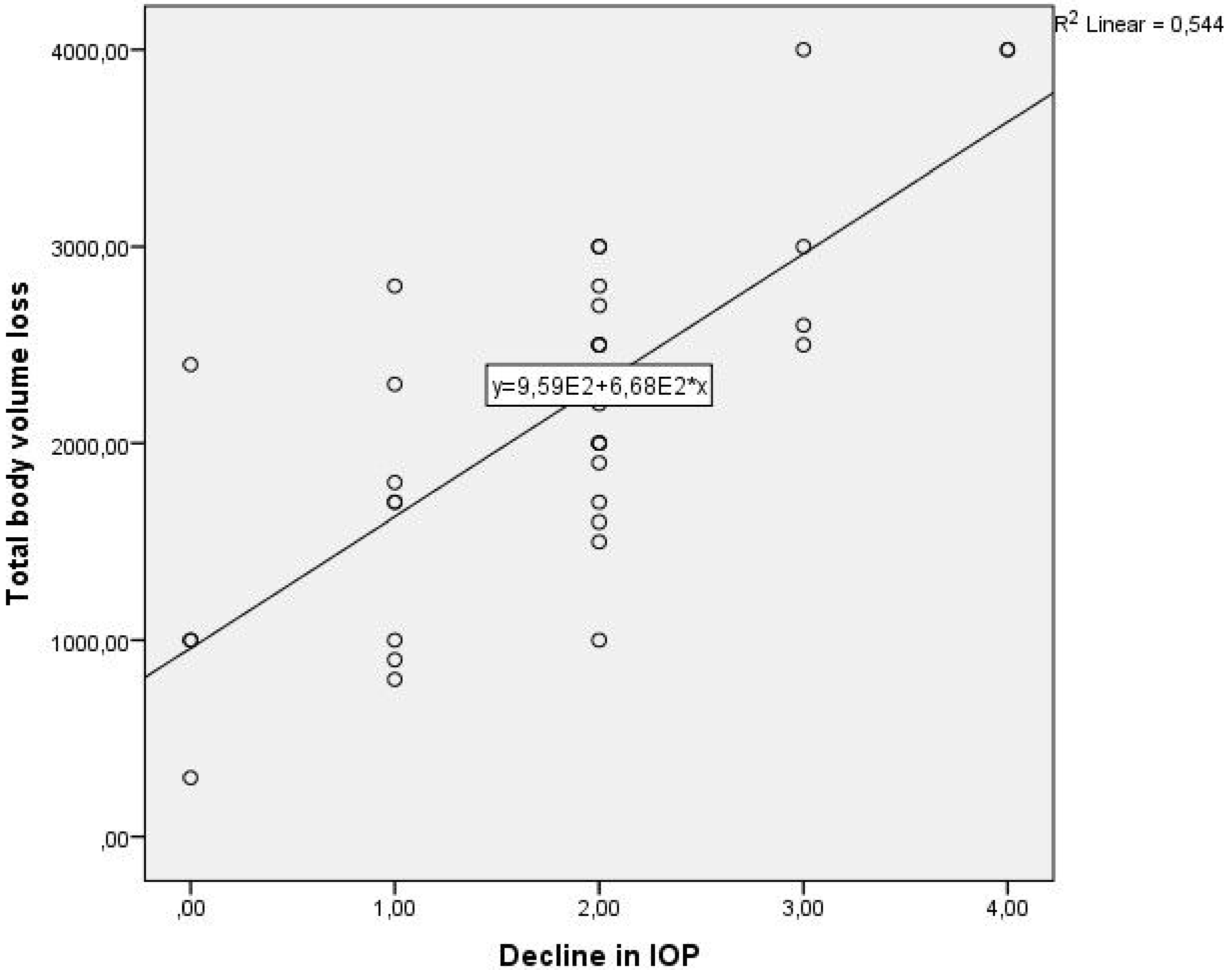

Figure 1

Correlation between total body volume loss and decline in intraocular pressure

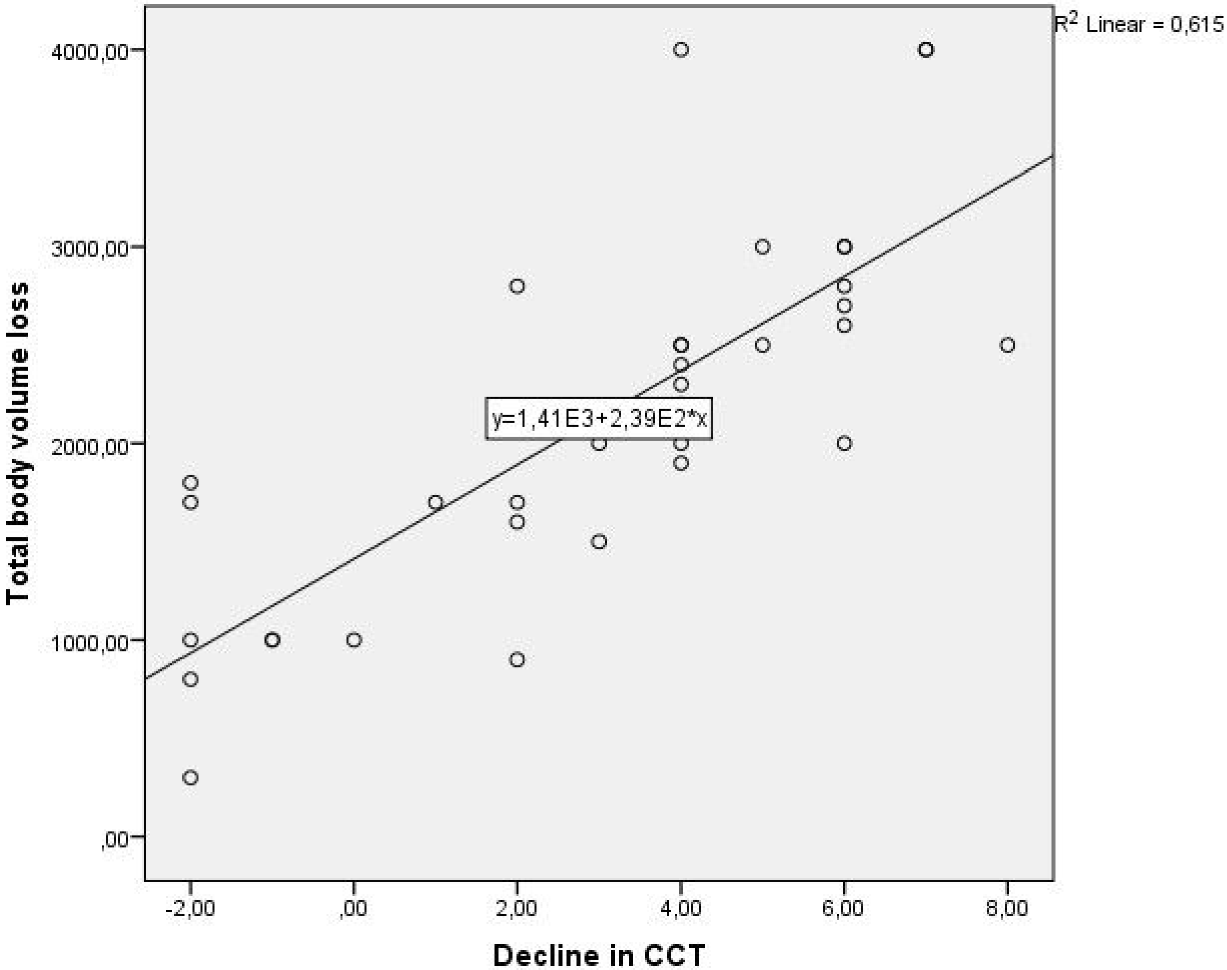

Figure 2

Correlation between total body volume loss and decline in central corneal thickness