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Original article

Evaluation of the acute effect of haemodialysis on retina and optic nerve with optical coherence tomography

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Abstract

Purpose: The primary objective of haemodialysis (HD) was to correct the composition and volume of body fluids. The aim of this study was to evaluate the acute effect of HD on mean arterial pressure changes and on retina and optic nerve with optical coherence tomography (OCT).
Methods: Fifty-three eyes of 28 patients were enrolled in this study. The patients' retinal and RNFL thicknesses were measured by OCT and mean arterial pressure alterations were recorded before and immediately after HD session.
Results: The results show that while there was a reduction at central foveal thickness and ganglion cell layer thickness, central subfield and RNFL thickness were increased with HD session. But none of them were statistically significant ($p = 0.320$, $p = 0.792$, $p = 0.744$, $p = 0.390$). The mean arterial pressure of the patients decreased significantly ($p < 0.05$) but it was not correlated with retinal and RNFL values.
Conclusion: The changes in retinal and RNFL findings were not significant. But these alterations may effect the long term follow-up of the patients with retinal and optic nerve disease. Therefore it is important to pay attention HD session time for these patients' measurements.

Keywords: Haemodialysis, Optical coherence tomography, Retinal thickness, RNFL thickness

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Introduction

Haemodialysis (HD) is the unique treatment modality for end stage chronic renal failure patients until the possible renal transplantation. With HD lots of alterations occur in patients' haemostasis and metabolic parameters. These alterations effect eye and may cause some pathologies such as refractive changes, dry eye, band keratopathy and some neuroophthalmologic complications.[1,2]

In most retinal and optic nerve disease, the evaluation of retinal nerve fibre layer (RNFL), fovea and recently ganglion cell layer thickness is very important. Spectral domain optical coherence tomography (SD-OCT) became a cornerstone for this examination. The fluctuations of measurements mostly affect the treatment decision.

In this study we aimed to evaluate of the acute effect of haemodialysis on mean arterial pressure changes and on retina and optic nerve with optical coherence tomography (OCT).

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Material and method

Chronic renal failure patients undergoing HD in the dialysis unit of Başkent University Zübeyde Hanım Research Hospital were recruited. Exclusion criteria were the presence of corneal opacity and/or dense cataract, intraocular inflammation, vitreoretinal pathologies or other causes of fixation loss. Informed consent was obtained from all of the patients.

All patients received 4 h HD each session and 3 times per week. The reason of chronic renal failure, duration of haemodialysis and the presence of diabetes mellitus (DM) were recorded. Systolic and diastolic arterial pressure of each patient was measured before and after HD session. After that mean arterial pressure (MAP) was calculated.

OCT images were acquired by an experienced technician. The patients' pupil were undilated during measurement. We used Cirrus SD-OCT (Carl Zeiss Meditec, Dublin, CA, USA) in this study. Measurements were acquired before and immediately after (max. 30 min.) HD session. Central subfield thickness, central foveal thickness, average ganglion cell layer thickness and RNFL thickness were recorded by OCT measurements.

This study adhered to the tenets of the Declaration of Helsinki to review the patient data.

Student's *t*-test was used to compare mean arterial pressure and all OCT measurements before and after HD sessions. Pearson's correlation test was used to reveal possible correlations between mean arterial pressure and OCT measurements. SPSS version 21.0 system was used for all statistical analyses and p value <0.05 was accepted as statistically significant.

Results

Fifty-three eyes of 28 patients were included in this study. There were 16 males and 12 females and the mean age was 53.57 ± 14.84 (20–77 years). 4 of the patients have DM and all any of these patients have diabetic retinopathy.

Mean duration of HD was 69.89 months (5–180 months). The reason of CRF was hypertension nephropathy in 28.6% of patients, urinary infection in 17.9% of patients, diabetic nephropathy in 10.7% of patients, urolithiasis, vesicoureteral reflux and polycystic kidney disease each of them 7.1% and the others (glomerulonephritis, renal carcinoma, unknown, etc.).

The data obtained using OCT are presented in Table 1. The measurements showed that central foveal thickness (−4.783 μm) and ganglion cell layer thickness (−0.57 μm) diminished with a single HD session. Adversely, central subfield (+1.32 μm) and RNFL thickness (+2.51 μm) increased with HD session. But these decline ($p = 0.320$, $p = 0.792$) and increase ($p = 0.744$, $p = 0.390$) in that values are not statistically significant.

Mean arterial pressure pre-HD was 88.75 mmHg and post-HD was 79.00 mmHg. This change in mean arterial pressure was statistically significant ($p < 0.05$). Decrease in MAP was not correlated with central foveal, ganglion cell layer, central subfield and RNFL thickness ($p = 0.764$, $p = 0.101$, $p = 0.454$, $p = 0.925$).

Discussion

Ocular impact of HD has been investigated in several studies. The main objective of HD was to correct the composition and volume of body fluids. During the HD, ultrafiltration increases plasma colloid osmotic pressure. In a study they found that the plasma colloid osmotic pressure is to be important in the hemodynamic changes that occur during HD.[3] These hemodynamic changes can affect the retinal circulation and these short term changes in the retinal vessels after a single HD session can explain the changes in retinal thickness.[4] Furthermore, changes in metabolic parameters cause the osmotic alterations in aqueous and vitreus humours.[5]

In different studies researchers[6–8] haven't seen any correlation between plasma colloid osmotic pressure and retinal thickness or macular volume. But total macular volume was significantly affected by changes in serum osmolality according to another study.[9] The exception of these Auyanet et al.[10] have suggested that retinal thickness can be affected from bath temperature. Beside changes in metabolic parameters, hypotension episodes can be seen after HD session.[11] The hypotension episodes can cause some ischaemic lesions[12] and some authors reported that nocturnal systemic hypotension may lead the worsening of visual field defects.[13]

So we evaluated the correlation between mean arterial pressure difference and retinal and RNFL thicknesses, but there was no significant correlation ($p = 0.764$, $p = 0.101$, $p = 0.454$, $p = 0.925$). Similarly, some studies[6,8,9] have found no correlations between mean arterial pressure gradient and retinal measurements.

In previous studies the authors have been showed the effect of systemic factors on macular oedema.[14] While some of these studies have been accepted the benefits of HD on macular oedema,[15] according to others it has no effect.[16] These studies have been designed on FFA and ophthalmoscopic examination results, and inherently macular or retinal thickness has not been evaluated. As far as we know, in the first study, which has been compared retinal and foveal thickness of HD patients and normal group, HD group has thinner retina than normal group but there was no difference at fovea.[17] But in this study the measurements were independent of HD time. After that in another study, foveal thickness tended to decrease with HD in patients with diabetic nephropathy.[10] We already know that resistant diabetic macular oedema is the most important cause of vision loss reason

Table 1. Effect of HD on the central foveal thickness, ganglion cell layer thickness, central subfield thickness, RNFL thickness and mean arterial pressure.

	PRE – HD (±SD)	POST – HD (±SD)	*p* Value
Central foveal thickness (μm)	255.48 (±9.96)	250.78 (±32.77)	0.320
Central subfield thickness (μm)	242.87 (±20.46)	244.19 (±21.07)	0.744
Ganglion cell layer thickness (μm)	81.55 (±9.41)	80.98 (±12.38)	0.792
RNFL thickness (μm)	91.04 (±14.11)	93.55 (±15.75)	0.390
Mean arterial pressure (mmHg)	88.75 (±9.39)	79.00 (±10.18)	0.000

HD haemodialysis, RNFL retinal nerve fibre layer.

in diabetic retinopathy. Ulaş et al. suggested that retinal thickness alteration is likely to be found at DM patients where blood-retina barrier is not totally intact.[7] To prove this hypothesis, DM patients' macular thickness decrease is more significant than non-DM group in certain studies.[6,9] Finally in a study, macular volume showed no significant differences before and after HD in non-DM patients.[8] In our study we evaluated DM and non-DM patients together. Central foveal thickness decreased and central subfield thickness increased but none of them could reach statistical significance ($p = 0.320$, $p = 0.744$).

In glaucoma patients RNFL thickness measurements are very important for diagnosis and monitoring. The authors showed axonal degeneration in uremic neuropathy with electron microscope.[18] Based on this study, the researchers suggested that the increase in RNFL thickness after HD session is relevant to improving the uremic situation of patients.[8] Pelit et al. observed statistically significant improvements in global indices after HD detected by automated perimetry and they proposed that the improvement in global indices was related to correction of hypervolemia and serum electrolyte levels.[19] In contrast to these, a study showed decrease of RNFL thickness in non-DM patients. They reported that, the presence of CRF can be a source of false positive results and lead to overestimation of glaucomatous optic neuropathy.[20] In another study, RNFL thickness showed no differences between HD sessions with scanning laser polarimeter.[21] In our study, RNFL thickness increased with HD session but it is not statistically significant ($p = 0.390$).

The basis of glaucoma development includes the degeneration of retinal ganglion cells resulting in characteristic cupping of the optic nerve with an accompanying pattern of visual field loss. Macular ganglion cells constitute approximately 50% of all RGCs.[22] SD-OCT ganglion cell complex measurements showed similar glaucoma diagnostic ability and was comparable with that of RNFL.[23] Also, according to the other study, ganglion cell complex, determined by SD-OCT, showed correlation to visual field mean sensitivity of a strength similar to that demonstrated between visual field mean sensitivity and RNFL thickness.[24] Thickness of the ganglion cell complex became an important parameter for diagnosis and monitoring for glaucoma. For this reason, in this study we evaluated the ganglion cell layer thickness. We detected a slightly decrease in this parameter but it could not reach statistically significant level ($p = 0.792$). The main difference and importance of our study are the evaluation of the ganglion cell layer thickness firstly in HD patients.

In conclusion, we have evaluated small and mix group of HD patients in our study. We have seen some differences in retinal and RNFL thicknesses that affected from HD although none of them were statistically significant. These alterations can easily effect the diagnose and monitoring of retinal and optic nerve diseases. In glaucoma patients, according to HD session time, RNFL and ganglion cell layer thickness measurements can show differences as we have demonstrated in our study.

Conflict of interest

The authors declared that there is no conflict of interest.

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