EFFECT OF HEMODIALYSIS ON MACULAR THICKENSS IN PATIENTS OF CHRONIC RENAL FAILURE WITH DIABETIC MACULAR EDEMA

Ophthalmology

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ABSTRACT

Introduction: End stage renal disease (ESRD) patients undergoing hemodialysis (HD) have higher incidence of diabetic retinopathy (DR) and diabetic macular edema. Optical coherence tomography (OCT) which both diagnoses and quantifies degree of macular edema is gold standard for evaluating macular thickness.

Materials And Methods: We studied 30 patients, with DR who were treated with hemodialysis for ESRD. All patients underwent OCT examination 30 minutes before and after a hemodialysis session. Blood pressure (BP), weight, serum osmolality, glycemic hemoglobin and albumin levels were measured before and after hemodialysis. Student's t-test and linear regression analysis test were used to analyze data. SPSS version 21.0 system was used for all statistical analyses and p value <0.05 was accepted as statistically significant.

Results: In our study, BCVA failed to change significantly after the HD. Central and average macular thickness decreased by 3.49% and 1.61% respectively, both were statistically significant. Changes in maximum, central and average macular thickness, as well as in total macular volume were found to be significantly affected by changes in serum osmolality (p=0.04, 0.002, 0.02 and 0.03, respectively). We found no significant changes in maximum/average macular thickness with changes in total body weight or in mean arterial pressure after HD.

Conclusion: Hemodialysis significantly decreases maximum macular thickness assessed by OCT in chronic renal failure diabetic patients with macular edema with no change in BCVA. Osmolality changes after hemodialysis were significantly associated with macular thickness.

KEYWORDS

End stage renal disease, Diabetic nephropathy, hemodiaysis, Diabetic macular edema, serum osmolality

INTRODUCTION

End-stage renal disease (ESRD) patients undergoing hemodialysis have a higher incidence of ophthalmologic pathologies, including diabetic retinopathy (DR), exudative retinal detachment, and cataract. DR and diabetic macular edema (DME) are common microvascular complications of diabetes mellitus and are a major cause of decreasing visual acuity and blindness.

Only a very small number of studies have examined the effects of hemodialysis on DME, and those also used fundus fluorescein angiography (FFA) and did report conflicting results. Some reported that hemodialysis is associated with resolution of hard exudates and a decrease in macular edema, while another stated that hemodialysis did not reduce diabetic macular leakage.

Optical coherence tomography (OCT), which both diagnoses and quantifies the degree of macular edema, is currently the gold standard for evaluating macular thickness. There are currently only three published studies on the effect of hemodialysis on macular thickness in diabetic patients measured by OCT, with conflicting results. According to two of them hemodialysis decreased retinal thickness, while the third demonstrated that foveal thickness did not change after one session of hemodialysis.

The aim of our study is to study whether hemodialysis could modify macular thickness in diabetic patient with ESRD or not and to evaluate possible correlation between changes in macular thickness during hemodialysis with changes in total body weight and serum osmolality in diabetic patients.

MATERIALS AND METHODS

Ethical measures were adhered to during entire study. Patients with ESRD due to diabetic mellitus who were undergoing hemodialysis and attended the tertiary care center were recruited over a 1.5 year period were included. Those with DR, 18 years and older, regularly treated in the hemodialysis unit 3 times a week for 4 hours each time were included. Exclusion criteria were retinal pathologies other than DR or opaque media (e.g., cataract), which precluded OCT images and inability to undergo the OCT examination due to mobility or cognitive difficulties. Informed consent was taken of all patients in their language.

Tropicamide (0.8% with phenylephrine (5%) combination eyedrops were used to dilate the pupils of the study eyes. OCT examination was done 30 minutes before and 30 min after a hemodialysis session with the Topcon OCT direct cross-sectional imaging device using the macular thickness protocol. Six consecutive scans were performed for each eye. The quantitative topographic map was divided into nine parts; a central circle representing the fovea, and two rings, each divided into four quarters: the internal ring represented the thickness of the perifoveal area and the external ring the thickness of the peripheral macula.

Blood pressure (BP), weight, serum osmolality was measured before and after hemodialysis, and the mean blood pressure was calculated. Glycemic hemoglobin and albumin levels were measured.

All data were expressed as means $\pm$ SEM. Student's t-test was used to compare hemodynamic changes and all OCT measurements before and after HD sessions. Linear regression analysis 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

A total of 30 eyes of 30 patients were studied from which 21 (70 %) were men and 9 (30%) were women.

The age of patients in our study varied from 18 to 80 years with mean age was 62 years.

In our study, body weight, mean serum osmolality was significantly different before and after HD sessions. BCVA failed to change significantly after the HD (P=0.06) (Table 1)

Table 1: Changes In Various Parameters Before And After Hemodialysis

	BEFORE hemodialysis	After hemodialysis	P value
Body weight(kg)	88.4 $\pm$ 0.99	87.36 $\pm$ 0.97	<0.001
Mean arterial pressure (mmHg)	95.15 $\pm$ 0.72	94.56 $\pm$ 0.66	0.002

Serum osmolality (mosm/kg)	352.984 +/- 1.79	328.384 +/- 1.96	<0.001
BCVA (decimal notation)	0.1169667 +/- 0.012	0.123067 +/- 0.012	0.06

*Data presents as means +/- SEM

In our study, central macular thickness decreased by 3.49% which was statistically significant. Average macular thickness decreased by 1.61% which was again statistically significant. Maximum macular thickness decreased by 5.89% and total macular volume is also decreased by 1.37%. (Table 2)

Table 2: Changes In Central Macular Thickness Before And After Hemodialysis

	Before Hemodialysis	After hemodialysis	Difference	P value
Central macular thickness,um	431.7 +/- 11.25	416.6 +/- 10.54	15.0 +/- 1.44	<0.001
Average macular thickness,um	385.3 +/- 5.66	379.08 +/- 5.66	6.22 +/- 0.53	<0.001
Maximum macular thickness,um	483.6 +/- 10.33	455.1 +/- 9.71	28.3 +/- 2.37	<0.001
Total macular volume,mm3	10.94 +/- 0.19	10.79 +/- 0.18	0.15 +/- 0.044	<0.05

*Data presented as means +/- SEM

In our study, majority of patients (11 out of 30) had cystic edema on OCT. 30 % of patients (9 out of 30) had spongy edema. 8 patients had mixed variety of edema.

According to our study population analysis, the areas of macula with maximum thickness and edema were outer quadrants in 21 eyes, inner quadrants in 6 eyes, and central fovea only in 3 eyes.

We have done linear regression analysis in our study which showed that osmolality changes significantly affected macular thickness changes. Changes in maximum, central and average macular thickness, as well as in total macular volume were found to be significantly affected by changes in serum osmolality ($p=0.04$, 0.002 , 0.02 and 0.03 , respectively). We found no significant association of changes in maximum/average macular thickness and total macular volume with changes in total body weight or in mean arterial pressure after HD. (Chart 1,2)

Chart 1: Association of maximum macular thickness with changes in serum osmolality

Chart 2: Association of central macular thickness with changes in serum osmolality

DISCUSSION

Ocular manifestations in ESRD patients and the effect of hemodialysis on ocular parameters have been investigated for several years.

In several studies, the effect of hemodialysis on diabetic retinopathy with or without macular edema was evaluated by FFA or ophthalmoscopy which provides only qualitative information about the retina. Tokuyama et al⁽¹⁾ found out that dialysis does not benefit macular leakage evaluated by fluorescein angiography in Diabetic patients with ESRD. On the contrary, an improvement in DME and hard exudates was shown in examination of patients after the beginning of hemodialysis sessions.

We agree with the studies done using OCT, and found out that hemodialysis benefits diabetic macular edema. We detected a mean decrease in maximum macular thickness in eyes with diabetic macular edema by 28.3% after each session of hemodialysis ($p<0.001$), as well as in the average macular thickness by 6.22 μm ($p<0.001$). The pathological areas with the maximum thickness and edema were mainly benefitted by the hemodialysis which were mainly in the peripheral parts of the central disc of 6 mm (21out of 30 eyes) according to our study. It is also noteworthy that the reduction in edema upon HD is similar in all areas; the localization of the edema (mostly in the Periphery) possibly explains why BCVA doesn't change significantly before and after HD. Retinal thickness only accounts for up to 27% of variability in concurrently measured VA suggesting that other factors are important determinants of VA in the presence of diabetic macular edema.⁽²⁾ Furthermore, we found that HD significantly reduces maximum macular thickness changed by 5.89% after each session of HD in these patients, while the average macular thickness and total macular volume changed minimally. This observation is consistent with the fact that areas with the maximum thickness would be affected more by volume changes following HD treatment.

Three recent studies employed OCT to evaluate the effect of hemodialysis on retinal thickness, some confirming our findings and others contradicting them.^(1,3,4)

In the first, the authors compared the retinal thickness of healthy people and HD patients of different etiologies, and found that HD patients showed a significant reduction in retinal thickness in the central disc (6mm) with respect to healthy controls. In contrast to this study, we examined only diabetic patients, all of whom had chronic renal failure and had been undergoing HD. Furthermore we performed OCT twice in each patient just before and after the HD session whereas in the study of pahor et al the OCT was performed once in each participant and at time points independent of HD session.⁽³⁾

In the second study, Auyanet et al the change of average foveal thickness with OCT prior to and after hemodialysis among patients with type 2 diabetes mellitus, only one of whom had macular edema. Our study measured changes in retinal thickness at the central fovea as well as in the inner macular ring and the external macular ring in ESRD patients with type 2 diabetes mellitus. The foveal thickness in the study of Auyanet et al. did not change after one session of hemodialysis in the 25 studied eyes apart from a slight (2%) and nonsignificant reduction, whereas our findings as mentioned earlier are contradictory to them. It also must be noted that Auyanet and coworkers⁽⁴⁾ did not mention the timing of the OCT exam.

In the third study, theodossiadiis et al. studied retinal thickness changes in diabetic and non-diabetic patient in ESRD patients, irrespective of their macular edema changes. In our study, we focused only on diabetic patients with macular edema. Their patients, like ours, were examined 30min before and 30min after hemodialysis treatment. These results are compatible with ours, Theodossiadiis et al.'s findings of no correlation between changes in retinal thickness and changes in body weight and mean arterial blood pressure after hemodialysis are in agreement with our data.⁽⁵⁾ After HD, both volume and composition of extracellular fluid changed dramatically causing weight and osmolality reduction, which was also observed in our study. However, change in the mean arterial pressure was less significant in comparison to body weight and osmolality. Possible explanation for avoidance of hypotension after hemodialysis would be the fact that solute and fluid were not removed in great quantities rapidly and that the central blood volume was preferentially conserved by increasing peripheral vascular resistance.

With respect to macular thickness changes we examined whether the

observed changes in macular thickness could be a result of fluid loss during HD. We detected with linear regression analysis a statistically significant impact of serum osmolality change on the maximum/average/ central macular thickness and total macular volume changes. Our results suggest that serum osmolality plays an important role in the changes in macular status. In addition we detected that the presence of diabetic macular edema is the most important factor affecting macular changes after HD.

Further research on a larger sample can help reaffirming our findings about the differences in retinal thickness recorded before and after hemodialysis.

CONCLUSION

In conclusion this study indicates that HD significantly decreases maximum macular thickness assessed by OCT in chronic renal failure diabetic patients with macular edema. The pathological areas with maximum thickness and edema, which were mainly benefitted by HD, were identified mostly in the periphery of the central disc of 6 mm, resulting in non-improvement of BCVA. Finally, average and maximum macular thickness changes were also reduced after HD in diabetic patients with macular edema. Osmolality changes due to HD were significantly associated with the macular thickness changes. These alterations in macular thickness after HD in patients with chronic renal failure can be further evaluated by similar studies.

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