

The Effect of Hemodialysis on Intraocular Pressure

(A Pilot Study on Renal Failure Patients at King Abdulaziz University Hospital)

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Abstract: We conducted this pilot study to evaluate the effect of HD on IOP in patients with chronic renal failure (CRF) at King Abdulaziz University Hospital (KAUH).

Method: A prospective, cross sectional observational study, was conducted on patients on HD at KAUH during the month of September 2016. IOP was measured with a Tonopen in both eyes, before, during, and after HD session. Demographic data were collected from patients' files. Body weight, systolic and diastolic arterial pressure were also measured before and after HD.

Results: 31 patients with a mean age and standard deviation of 48.58 ± 18.16 years were studied. Patients had been on HD for a mean period of 63.29 ± 57.07 months. The main causes of CRF were diabetes mellitus (DM), renal diseases, and hypertension. No significant effect of HD on IOP in 29 patients during and post HD ($P = 0.776$). 7 patients were on systemic B-blocker for hypertension, and one patient was on anti-glaucoma eye drop xalatan for glaucoma. 2 patients had significant increase of IOP during and post HD ($P < 0.045$). Body Weight and arterial pressure significantly decreased during HD ($p=0.001$, $p=0.002$) respectively.

Conclusion: No significant effect of HD on IOP in most patients, however, only 2 patients had significant increase of IOP. 8 patients were on systemic B-blocker and topical anti glaucoma eye drop, which may under estimate the effect of HD on IOP. HD significantly decrease body weight and blood pressure.

Keywords: HD session, diabetes mellitus (DM), IOP.

1. INTRODUCTION

There are about 15000 end stage renal disease (ESRD) patients on dialysis in Saudi Arabia, with a mean age of 54.5 years. ¹ Since age is a major risk factor for glaucoma; older patients undergoing hemodialysis (HD) for ESRD would be at great risk to develop glaucoma.

Transient increase of Intraocular pressure (IOP), which is a major risk factor for glaucoma development, has been reported during HD sessions in patients with and without glaucoma. ²⁻¹¹

The relationship between IOP changes and HD has been reported for the first time in 1964 by Sitprija and his group. ² Researchers have looked at several key factors that influence the effect of HD on IOP such as; IOP measurement method, dialysis type, time of IOP measurements and the duration of dialysis, and developed various theories. ¹² The effect of HD on IOP varies in literature from significant spikes to drops in IOP, and some studies have shown no effect. ¹³ The IOP changes during HD depends upon the net effect of several factors, which include, aqueous outflow facility, individual aqueous humor dynamics, and the dialysis prescription. These variables may interact to raise, lower or have no effect on IOP. ¹⁴ The most accepted mechanism for IOP increase during HD was the reduction in colloid osmotic pressure or total serum osmolality in patient's vascular system. This is mainly due to loss of urea, which lead to increase of aqueous production through increase diffusion. ¹²

Recently, a strong correlation between optic nerve glaucomatous damage and low diastolic arterial pressure during HD was suggested, secondary to ischemia from inadequate ocular perfusion pressure to optic nerve.¹⁵

This pilot study was conducted to evaluate the changes in IOP, and its relationship with systemic hemodynamic parameters, (body weight, systolic and diastolic arterial blood pressure), before, during, and after a single HD session in patients with ESRD.

2. MATERIALS AND METHODS

A prospective, cross-sectional, observational pilot study was conducted in September 2016 on patients with ESRD who were undergoing maintenance HD at King Abdulaziz University hospital (KAUH).

All participants signed an informed consent form, which was approved by the research committee of the Unit of Biomedical Ethics of King Abdulaziz University.

All HD patients receive dialysis 3 times a week, with session duration of 3 to 5 hours. High-performance dialyzers (polysulfone) were used at a blood flow rate of 500 to 600 ml/min, and the systemic circulation was accessed through an arteriovenous fistula.

Patients were excluded from participation in the study if they had a preexisting corneal abnormality, a prior corneal surgery, an allergy to topical anesthetic agents, or a current eye infection.

IOP was measured using a Tono-pen Tonometer (Reichert Inc, NY, USA). It was measured at three different times: 15 minutes before starting HD, 2 hours after initiation of HD, and 15 minutes after ending HD session.

Body weight, systolic and diastolic arterial pressure were also measured before and after HD. Blood pressure was measured with an automated sphygmomanometer (CAS Medical System Inc. Branford, USA) on the upper arm over the brachial artery with the patient sitting upright. We considered the guidelines of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Arterial Pressure for this research, which describe normal arterial pressure as systolic arterial pressure ≤ 120 mmHg and diastolic arterial pressure ≤ 80 mmHg.¹⁶

Statistical Analysis:

Continuous variables were expressed as mean \pm standard deviation or as a percentage. Comparisons between IOP and arterial pressure at the three time points were made using paired 2-tailed t tests. The Pearson correlation coefficient was calculated and used to determine the statistical significance of linear correlations. SPSS 19.0 for Windows was used for statistical analysis. Statistical significance was defined as $P < 0.05$.

3. RESULTS

62 eyes from 31 patients, 15 male and 16 female, with a mean age \pm SD of 48.58 ± 18.16 (range 17-77) years were studied. (Table 1) The average duration of HD treatment was 63.29 ± 57.07 (range 1 - 192) months. The predominant causes of ESRD were diabetes mellitus, renal diseases, and hypertension (Table 2).

2 (6.5%) patients developed significant high IOP while on HD and after it was stopped ($P < 0.045$). No significant effect of HD on IOP in 29 (93.5%) patients during and post HD ($P = 0.776$). 7 (22.6%) of the 29 patients were on systemic B-blocker for hypertension, and one (3.2%) patient was on anti-glaucoma eye drop (Xalatan) for glaucoma. 5 (16.1%) patients had positive family history of glaucoma and none of them had significant effect of HD on IOP.

Body Weight and arterial pressure significantly decreased during HD ($p=0.001$, $p=0.002$) (Table 3 and 4), respectively, with no significant effect on IOP.

Table 1. Demographic parameters at baseline (n=31)

Demographic parameters	
Age (years)	48 \pm 18.16
Male	15
Female	16

Table 2. Etiologies of end stage renal disease (ESRD) at a baseline (n=31)

Etiology	Percent of patients
Diabetes Mellitus (DM)	58%
Renal Diseases	35%
Hypertension (HTN)	25.80%
Unknown	19.40%

Table 3. Effect of HD on body weight

Stage of Hemodialysis (HD)	Average Body Weight (kg)
Before HD session	62.45 ± 18.10
After HD session	59.52± 17.11

Table 4. Effect of HD on Arterial pressure

Stage of Hemodialysis (HD)	Average Arterial Pressure Before HD	Average Arterial Pressure After HD
Systolic Blood Pressure (mmHg)	150 ± 22.49	133.06 ± 21.78
diastolic Blood Pressure (mmHg)	87.20 ± 15.54	73.68 ± 21.85

4. DISCUSSION

The effect of HD on IOP has been extensively reported in literature, with significant variation in the results. High spikes as well as drops in IOP during HD have been reported, and some studies have found that HD has no effect on IOP.¹³ Many factors were found to influence the variability of the reported findings, and one theory suggests that the reversal in IOP change between earlier and recent studies is attributable to a newer HD techniques using a slower dialysis process, resulting in slower hemodynamic changes that don't affect the IOP.¹⁸

To the best of our knowledge no previous studies were conducted in Saudi Arabia to find out the effect of HD on IOP. Our pilot study demonstrates a statistically none significant effect of HD on IOP among the majority of patients. In contrast to other earlier studies which demonstrated an increase in IOP when hemodynamic changes occur during HD.²⁻⁵

Eventhough, our study demonstrates that there is no significant change in IOP during HD in most of cases; two patients showed a significant increase of IOP. 7 patients where on systemic anti-hypertension (Beta-blocker) medications, which is known to lower IOP, and one patient was on Xalatan; an anti-glaucoma medication. In those 8 patients, the IOP could be under estimated, and therefore, the effect of HD was masked.

Our study showed that body weight and arterial pressure significantly decreased during HD, but without any effect on IOP. Similar observation has been reported in several studies,¹⁹⁻²² and one study showed, that lower diastolic arterial pressure is a significant risk factor for glaucoma.²³ Two studies suggested that people with field defects have significantly decreased arterial pressure/IOP ratios.^{13, 24} Moreover, a study has reported that the hypotension following dialysis could cause anterior ischemic optic neuropathy (AION) both in children and adults.²⁵ All these studies revealed a strong correlation between anatomico-functional glaucoma damage and the presence of low arterial pressure.

Our study has many limitations, which could affect the results, (a) the small number of patients, (b) the IOP was measured in a single session and it's not known whether our results will be consistent for each patient during different HD session, (c) some patient were on medications which affect the IOP, (d) small number of patients diagnosed to have glaucoma based on patient self-repot.

A future study with larger sample size and repeated IOP measurements during multiple HD sessions, optic nerve assessment, and visual field test in suspected cases, is needed to show if HD is a risk factor for developing glaucoma.

5. CONCLUSION

Our results didn't support the majority of reported findings of HD effect on IOP. However, some patients showed a significant increase of IOP. Several patients were on systemic B-blocker and topical anti-glaucoma medications, which may under estimate the effect of HD on IOP. Further study of a large number of patients on no IOP suppression medications, with optic nerve assessment, and visual field test in suspected cases, is advisable to show if HD is a glaucoma risk factor.

Conflict of interest:

The authors have no conflict of interest to declare.

Authors' contributions:

All authors participated in the manuscript preparation and review, critically assessing and approving the final draft and are responsible for the content and similarity index of the manuscript.

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