



## TO ANALYZE THE TEMPORAL EFFECT OF HEMODIALYSIS ON INTRAOCULAR PRESSURE AND OCULAR PERFUSION PRESSURE

### Ophthalmology

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### ABSTRACT

**Purpose-** To analyze the temporal effect of hemodialysis on intraocular pressure and ocular perfusion pressure **Materials and Methods-** This was a prospective study done after obtaining approval from Institutional Ethics Committee. 140 eyes of patients with end-stage renal disease undergoing Hemodialysis ( HD) were enrolled, after obtaining informed consent as per the tenets of declaration of Helsinki. Best Corrected Visual Acuity(BCVA) was recorded using Snellen's chart. IOP was measured using Perkin's applanation tonometer, at each of the following points: T1 was at the start of dialysis, T2, 2 hours after starting dialysis, and T3, at the end of dialysis. Ocular Perfusion Pressure(OPP) at each time point was calculated. **Results-** Out of the 140 eyes examined, Patients with an initial IOP (T1) of 20 or more were 23. Patients with a second IOP (T2) of 20 or more were 30. Patients with a final IOP (T3) of 20 or more were 15, T1, T2, T3 were statistically significant ( $p=0.000$ ). Fifteen patients were found to have an OPP1 of  $\leq 50$ . Sixteen patients had an OPP2 of  $\leq 50$ , Forty-five patients had an OPP 2 of more than 60. Ten patients had an OPP3 of less than 50, were statistically significant ( $P=0.000$ ). **Conclusion:** There were significant fluctuations in the IOP between the mid dialysis and end of dialysis which is risk factor for glaucoma progression. Hence IOP monitoring is crucial during dialysis

### KEYWORDS

Hemodialysis ( HD), Ocular perfusion pressure(OPP) Intra ocular pressure (IOP) MAP=Mean arterial pressure, glaucoma

### INTRODUCTION

Haemodialysis(HD) forms an important modality in the armamentarium of treatment of End-Stage Renal Disease<sup>[1]</sup>The prevalence of chronic kidney disease at the community level is 8600 per million population<sup>[2]</sup> The prevalence of glaucoma in India is 11.9 million. Considering that the age of the patient is a risk factor for glaucoma development in the setting of hemodialysis, where the patients are usually in the older age group, the probability of these patients developing glaucoma is higher.

Intraocular pressure (IOP) is an important risk factor for the development of glaucoma, and transient increase in the intraocular pressure during HD has been reported<sup>[3]</sup>The main objective of HD is to treat the abnormal distribution of body fluid. Hemodialysis causes a decrease in serum osmolality, resulting in an osmotic gradient between the plasma and the intraocular fluids due to the presence of the blood-ocular barrier.

Hence, haemodialysis results in change in the ocular fluid volume and content. Notwithstanding the osmotic gradient that draws water into the eye from the plasma, if there is no abnormality in the normal aqueous humor dynamics, no increase in IOP occurs. However, where there is an obstruction in the aqueous humor pathway, homeostasis is not maintained, resulting in raised IOP<sup>[4,5]</sup> Hence the changes in the ocular fluid volume and composition can lead to changes in the IOP. This, in turn, can lead to changes in the ocular perfusion pressure, which is detrimental to the health of the optic nerve head.

Hypertension per se can raise the intraocular pressure by increased production or reduced outflow of aqueous. The coexistence of systemic hypertension in patients undergoing HD, and the antihypertensive medications that they are on, can influence the IOP and its changes during the procedure<sup>[6,7]</sup>Diabetes is also a common association in patients undergoing hemodialysis. Studies suggest that the IOP of both adult and juvenile diabetics was more than the IOP in patients with no diabetes<sup>[8]</sup>

Hence we measure the fluctuation in the IOP and the Ocular perfusion pressure (OPP) which can lead to optic nerve head changes and hence visual field loss, in patients undergoing HD, including those with systemic hypertension and diabetes mellitus.

### Methods

This was a prospective, cross-sectional, single-center study, done after procuring approval from Institutional Ethics Committee. One hundred and forty eyes of patients with end-stage renal disease undergoing HD were enrolled, after obtaining informed consent. A

complete history was obtained, with details regarding duration and frequency of HD, and whether or not the patient had hypertension or diabetes. In addition, details regarding ocular history were noted. Best Corrected Visual Acuity(BCVA) was recorded using Snellen's chart. IOP was measured using Perkin's applanation tonometer, at each of the following points: T1 was at the start of dialysis, T2, 2 hours after starting dialysis, and T3, at the end of dialysis. Anterior segment evaluation was done using a slit lamp biomicroscope. Dilated fundus was examined using an indirect ophthalmoscope.

The blood pressure was recorded in the right upper limb in the supine position. Ocular Perfusion Pressure(OPP) at each time point was calculated using the formula,  $OPP=MAP-IOP$ . ( $MAP=Mean\ arterial\ pressure$ ;  $MAP=diastolic\ BP+ 1/3(systolic\ BP-diastolic\ BP)$ ). OPP was calculated for each temporal point as OPP1- the start of dialysis, OPP2- 2 hours after starting dialysis, OPP3- at the end of dialysis.

For statistical analysis, the Statistical Package for Social Sciences(SPSS version 18 SPSS Inc., Chicago, IL, USA) was used. The chi-square test and paired t-test were used, and a p-value less than 0.05 was considered statistically significant.

### RESULTS:

Out of the 140 eyes examined, 26 % were those of females and 74 % were those of males. Among them, 9(12.9%) were in the age group between 20 and 40, 29(41.4%) were in the age group between 40 and 60, and 32(43.2%) were in the age group more than 60. Diabetics constituted 49.3 % of the patients, while 93.1 % of the patients were hypertensives.

Patients with an initial IOP(T1) of 20 or more were 23, out of which 13(56.5%) patients were more than 60 years old, 2(8.6%) patients were less than 40 years old. This was statistically significant( $p=0.000$ ). Patients with a second IOP (T2) of 20 or more were 30, out of which 14(46.67%) were more than 60 years old, 6(20%) were less than 40 years old. This was also statistically significant( $p=0.000$ ). Patients with a final IOP (T3) of 20 or more were 15, out of which those who were 60 years or more were 6(30%), and those who were less than 40 were 2(13.33%) ( $p=0.000$ ). Hence, patients in the older age group had a higher mean IOP.

Fifteen patients were found to have an OPP1 of  $\leq 50$ , out of which 11 patients were more than 60 years old, while none of the patients were below forty years old. Seventy-six patients had an OPP1 between 51 and 60, out of which 27 were more than 60 years old, while 12 were less than 40 years old. Forty-nine patients had an OPP1 of more than 60, of which 25 of whom were more than 60 years old, while 6 were less than

40 years old. The p-value was 0.000

Sixteen patients had an OPP2 of  $\leq 50$ , out of which 14(87.5%) patients were more than 60 years old, none were less than 40 years old. Seventy-nine patients had an OPP2 between 51 and 60, out of which 34(43%) were more than 60 years old, while 14(17.7%) were less than 40 years old.

Forty-five patients had an OPP 2of more than 60, out of which 21(46.67%) were more than 60 years old, while 4(8%) were less than 40 years old. The p-value of this as well as 0.000

Ten patients had an OPP3 of less than 50, out of which 9 patients were more than 60 years old, and none were less than 40 years old. Seventy-three patients had an OPP3 between 51 and 60, 32 more than 60 years, while 12 were less than 40.56 patients had an OPP3 more than 60, out of which 25( 34.25%) were more than 60 years old, while 5 were less than 40 years old. (P=0.000)

Hence, patients in the older age groups had a lower mean OPP On conducting the paired samples test, it was found that the change in the IOP from T2 to T3 had a p-value of 0.176, while the change in IOP from T1 to T2 was statistically significant with a p-value of 0.05. The change from T1 to T3, however, was not statistically significant.

On applying the similar test to the Ocular perfusion pressure, there was no statistical significance in the difference between the OPP1, OPP2, and OPP3. The changes in IOP from T1 to T2 are shown in table 1. Changes in IOP from 2nd to 3rd reading is shown in Table 2. ( $p > 0.05$ ). Changes in IOP from T1 to T3 are shown in Table 3. ( $p > 0.05$ ) Hence, the fluctuation of IOP was statistically significant in the early part of the dialysis, but the IOP did not change from the beginning to the end of the dialysis.

The mean change in IOP in patients in whom heparin was not used during dialysis was  $-3.60 \text{ mm Hg} \pm 8.173$  and the mean change in IOP in those where heparin was used during dialysis was  $0.95 \pm 4.415$  ( $p = 0.031$ ). Hence the higher the amount of heparin used, there was a decrease in the IOP throughout dialysis ( $p = 0.05$ )

The comparison of weight gain with the change in the intraocular pressure is shown in table 4. Patients with a higher weight gain had a statistically significant change in the IOP, at the end of dialysis.

On comparing the weight gain with the change in the ocular perfusion pressure throughout dialysis, the following was seen-which is shown in table 5. Hence, patients with a higher weight gain had more fluctuation in OPP throughout dialysis. ( $p = 0.029$ )

The fluctuation of IOP in patients with diabetes mellitus was found that patients with diabetes had a lesser incidence of decrease in the IOP, and had a higher incidence of increase in IOP during the period of dialysis even when the patient had been on dialysis for a fewer number of years. ( $P = 0.012$ )

On comparing the period of dialysis and the change in the IOP from the first to the final reading of the IOP, the following was noted, as shown in table 6. As the number of years of dialysis increases, there is a decrease in IOP throughout dialysis, whereas with a fewer number of years of dialysis there was an increase in the IOP throughout dialysis. ( $p = 0.000$ )

When the frequency of dialysis was compared with the fluctuation of IOP, it was found that patients with a frequency of either twice or thrice a week of hemodialysis did not have a significant difference in the fluctuation of IOP. ( $p > 0.05$ ). Hence the frequency of dialysis did not have a bearing on the IOP fluctuation.

## DISCUSSION

There have been many studies performed to assess the effect of HD on IOP and OPP. But there have been no conclusive results. In our study, in addition to the above, we also have assessed whether the use of heparin during dialysis, the duration of dialysis, the weight gain, and the frequency of dialysis have an impact on the IOP.

According to a study done by Jung et al, mean IOP decreased after hemodialysis with a mean decrease of  $2.4 \pm 2.1 \text{ mmHg}$ . mean IOP significantly decreased. According to our study, though there was no

statistically significant change in the IOP from the first to the last reading, there was a statistically significant decrease in the IOP from the mid dialysis value to the end of the dialysis value<sup>[4,9,10]</sup>

It was found that the change in the IOP from T1 to T2 was found to have a p-value of 0.176, while the change in IOP from T2 to T3 was statistically significant with a p-value of 0.005. The change from T1 to T3, however, was not statistically significant.

Hu et al found that there was a significant decrease in OPP from the baseline value.<sup>3</sup> But in our study, there was no statistical significance between OPP1, OPP2, and OPP3.

IOP tended to increase after hemodialysis when hemodialysis more than 12 years. In our study, we found that, as the number of years of dialysis increases, the incidence of increase of IOP from T1 to T3 decreases, and the incidence of decrease of IOP from T1 to T3 increases.

In non-diabetics, the mean IOP significantly decreased after hemodialysis. In our study, we found that there was a significant increase in the IOP in diabetics<sup>[11]</sup>

In a study done by Ngo et al, it was found that a significant, negative correlation was observed between changes in IOP and OPP in overweight patients<sup>[12]</sup> Hu et al found that the factors associated with systemic haemodialysis, such as change in plasma osmolality, volume of ultrafiltrated fluid and change in body weight did not influence the IOP or OPP<sup>[3]</sup> We found that a weight gain of more than 5 kgs caused a statistically significant change in the ocular perfusion pressure. Also, when the weight gain was more than 3 kgs, there was a decrease in the IOP of  $-0.5135 \pm 3.124$ , while when the weight gain was less than or equal to 3 kgs, there was an increase in the IOP of  $1.21 \pm 3.26$ , which was statistically significant.

There are very few articles in the literature that compare the amount of heparin used during hemodialysis and IOP fluctuations, as well as the frequency of dialysis and IOP fluctuations. We found, in our study, that when a higher amount of heparin was used there was a more pronounced decrease in the IOP, especially from the start of dialysis to the middle of dialysis values. Also, we found that the frequency of hemodialysis did not affect the IOP changes during the period of dialysis.

Our study has both strengths and limitations. We examined a total of 140 eyes, which is a significant number, and all of whom were South Indian. Very few such studies have been done on the Indian population. Also, we have compared the effect of heparin on the IOP fluctuation, which has not been found many mentions in literature. Our limitations are that we have assessed the IOP fluctuation only in a single session. As our population consisted mainly of hypertensives, the role of hypertension or its lack thereof, on the IOP fluctuation could not be assessed.

## CONCLUSION:

Our study suggests that as patients undergoing hemodialysis are usually in the older age group, and glaucoma also affects patients in the same group, it becomes imperative to check their intraocular pressure. There are significant fluctuations in the IOP between the mid dialysis and end of dialysis values, which becomes an important factor for glaucomatous progression in an eye that is compromised. In diabetics and patients with a higher weight gain, closer monitoring of IOP would aid in identifying patients at risk. Our study also suggests that a higher amount of heparin can be used in the process of dialysis, for patients at risk. Hence, in the setting of hemodialysis in patients with glaucoma, the involvement of both a nephrologist and an ophthalmologist is crucial.

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Heparin	IOP raise>4	IOP decrease>4
0	0	0
2000	14(42.42%)	6(18.18%)
3000	5(38%)	0
4000	4(21%)	6(46.15%)
5000	1(25%)	2(50%)

Table 1- Comparison of dose of heparin used with the change in IOP from T1 to T2

Heparin	IOP increase >4	IOP decrease >4
0	0	1(33.33%)
2000	1(33.33%)	7(23.24%)
3000	0	5(45.45%)
4000	4(23.5%)	5(29.4%)
5000	0	0

Table 2- Comparison of dose of heparin used with the change in IOP from T2 to T3

Heparin	IOP increase>4	IOP decrease>4
0	0	0
2000	5(16.67%)	4(13.33%)
3000	4(36.36%)	0
4000	0	5(29.4%)
5000	0	2(50%)

Table 3 -Comparison of dose of heparin used with the change in IOP from T1 to T3

Weight gain in kgs	T2-T1	T3-T2	T3-T1
>=3	0.21+-5.064	-1.23+-2.709	-0.5135+-3.124
<3	1.71+-3.913	-0.81+-3.272	1.21+-3.26
p value	0.061	0.433	0.003

Table 4- Comparison of weight gain with change in IOP

Weight gain in Kgs	Change in OPP upto 5	Change in OPP>5	No change in OPP
0(1)	0	1	0
1-2(30)	19(63.3%)	4	6(20%)
3-4(36)	28(77.78%)	3	5(13.89%)
>=5(3)	3(100%)	0	0

Table 5- Comparison of weight gain with change in Ocular perfusion pressure

Period of dialysis	IOP decrease of more than 8	IOP decrease between 2 and 8	No change	IOP increase between 2 and 8	IOP increase of more than 8
Upto 2	2	26(30.2%)	20(23.2%)	36(41.8%)	2(2.3%)
3-5	0	12(42.8%)	5(17.8%)	9(3.2%)	2(7.14%)
>5	0	7(53.8%)	4(30.7%)	2(15.3%)	0

Table 6- Comparison of period of dialysis with change in IOP

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