DOI: 10.47799/pimr.1002.05

A study of changes in Mean Ocular Perfusion Pressure and Intra-Ocular Pressure among patients undergoing hemodialysis

DK Seethalakshmi[1]*, Savitha Kanakapur[2], Supriya DK[3]

[1]Associate Professor, Department of Ophthalmology, Karnataka Institute of Medical Sciences, Hubali, Karnataka, India
[2]Professor and Head,Department of Opthalmology, Karnataka Institue of Medical Sciences, Hubali, Karnataka, India
[3]Senior Resident,Department of Ophthalmology, Karnataka Institute of Medical Sciences, Hubali, Karnataka

[*]*Corresponding Author:*
DK Seethalakshmi, Associate Professor, Department of Ophthalmology, Karnataka Institute of Medical Sciences, Hubali, Karnataka, India
E-MAIL: diddapurdk12@gmail.com

Date of Submission: 30/11/2021 **Date of Review: 12/03/2022** **Date of Acceptance: 07/05/2022**

ABSTRACT

Background: During hemodialysis there is decrease in both systolic blood pressure (SBP) and diastolic blood pressure (DBP) and hence Mean Arterial Pressure (MAP) due to decrease in body fluid volume. Due to reduction in MAP there is decrease in Mean Ocular Perfusion Pressure (MOPP) and also there is increase in IOP during dialysis.

Objective: To study changes in MOPP and IOP among patients undergoing hemodialysis

Methods: An observational study was carried out among 100 patients undergoing hemodialysis Under aseptic condition, Proparacaine eye drops were instilled in both eyes, IOP was measured by Schiotz Indentation Tonometer 30 min before, during hemodialysis and 30 min after hemodialysis in supine position. Tonometer was sterilized by Isopropyl alcohol and was washed with normal saline before using on next patient. Systolic and diastolic blood pressure were measured by using sphygmomanometer 30 min before, during and 30 min after hemodialysis.

Results: The variations in the SBP, DBP and MAP before, during and after hemodialysis were not statistically significant ($p>0.05$). There was significant differences for IOP between before, during and after hemodialysis and same for MOPP except before and 30 min after hemodialysis ($p < 0.0001$).

Conclusion: Significant fluctuations were seen from the present study in the intra-ocular pressure and mean ocular perfusion pressure during, before and after hemodialysis.

KEYWORDS: intra-ocular pressure, hemodialysis, renal disease, Mean Ocular Perfusion Pressure

INTRODUCTION

About 1.5 lakh patients develop End Stage Renal disease every year in India and are essentially treated by Hemodialysis. [1]

Effects of Hemodialysis on eye are many including aggravation of Dry eye symptoms, Refractive changes, Central Corneal Thickness, changes in Retinal Nerve Fiber Layer Thickness, Choroidal thickness and changes in the Intraocular pressure (IOP). [2]

Intraocular pressure normal distribution in general population is 12-21mm Hg. This is just numerical terms, as 30-50% of patients in general population who have glaucomatous optic neuropathy and/or visual field defects have initial screening IOP level of less than 22 mm Hg. [3] Many patients may not develop any glaucomatous optic disc changes even when pressures are raised. The Normal IOP is the pressure which does not lead to glaucomatous damage of optic nerve head. [4] There are many factors affecting IOP. It can be genetic factors which affects both IOP levels in a person and IOP response to glaucoma medications.

Environmental factors can be Gravity, Exposure to cold air, Tobacco, Smoking, Drugs, LSD, anticholinergic, antihistamine, psychiatric drugs and general anesthesia. With age, IOP increases. IOP has cyclic fluctuations throughout the day with peak IOP in the morning.

Systemic condition contributing to increased IOP are Diabetes mellitus and Blood pressure.Translamilar pressure varies independently of IOP and important for the pathogenesis of glaucoma. It is in turn dependent upon CSF pressure, which is found to be low in POAG patients. [5]

Normal perfusion pressure is required for adequate perfusion of tissue and its proper functioning. Reduced Ocular perfusion pressure and Increased IOP is both considered as risk factor for POAG. Low perfusion pressure less than 50-55 is risk factor for development of glaucoma and also progression of glaucoma. [6] IOP is not the only one factor for development of glaucoma as many patients develop glaucoma even within normal range of IOP. So this leaves us with other mechanism of development of glaucoma like vascular dysregulations.During hemodialysis it is found to be decrease in both systolic blood pressure (SBP) and diastolic blood pressure(DBP) and hence Mean Arterial Pressure (MAP) due to decrease in body fluid volume. Due to reduction in MAP there is decrease in Mean Ocular Perfusion Pressure (MOPP) and also there is increase in IOP during dialysis. [7] So both factors favors the progression of Glaucoma if already diagnosed or act as a risk factor if patient is predisposed to glaucoma.

With this background, present study was undertaken to study the changes in the MOPP and MAP among patients undergoing hemodialysis.

METHODOLOGY:

100 patients with age 50.3+/-14.5 years undergoing haemodialysis at Nephrology department KIMS Hubli were considered in this study. Among them 58 patients were male and 42 were females. It was an observational study conducted after obtaining institutional ethical committee clearance Under asceptic precautions Proparacaine eye drops were instilled in both eyes, IOP was measured by Schiotz Indentation Tonometer 30 min before, during and 30 min after hemodialysis in supine position.Tonometer was sterilized by Isopropyl alcohol and was washed with normal saline before using on next patient. Systolic and diastolic blood pressure was measured by using sphygmomanometer 30 min before, during and 30 minutes after hemodialysis.

T1, T2, T3 represents IOP and MOPP readings pre hemodialysis, during and after hemodialysis respectively.MAP (mean arterial pressure)and MOPP(mean ocular perfusion pressure) was calculated by the below mentioned formula.

MAP =DBP +1/3(SBP-DBP)

MOPP=2/3 MAP-IOP

Inclusion criteria were all patients undergoing hemodialysis at nephrology department KIMS, Hubli while exclusion criteria were Patients with corneal diseases,eye infections,Hepatitis B,allergies to topical anesthetic agents.

Statistical analysis: Analysis of variance (ANOVA) was used to compare the changes of IOP and MOPP at different time of assessment during Hemodialysis. Results are presented as Mean+SD values. P value of less than 0.05 was considered statistically significant.

RESULTS

The SBP reduced from T1 to T2 from 156.2+/-17.3 mm Hg to 151.4+/-16.6 mm Hg with mean reduction of 4.8+/-2.4 mm Hg. The SBP increased from T2 to T3 from 151.4+/-16.6 mm Hg to 154.4+/-17.0 mm Hg with mean increase of 3.0+/-2.2 mm Hg but these variations were not found to be statistically significant (p > 0.05). The DBP reduced from T1 to T2 from 91.0+/-11.3 mm Hg to 87.7+/-10.6 mm Hg with mean reduction of 3.3+/-2.9 mm Hg. The DBP increased from T2 to T3 from 87.7+/-10.6 mm Hg to 89.8+/-10.5 mm Hg with mean increase of 2.1+/-3.7 mm Hg. The T3 DBP have not reached the pre-hemodialysis level that is, from T1 to T3 there is mean decrease of 1.2+/-3.4 mm Hg. The variations in the DBP were also not found to be statistically significant. Table 1

Time	Mean arterial pressure (mmHg)	F value	P value
T1	112.8+/-12.4	2.568	0.0783
T2	109.0+/-11.6		
T3	111.2+/-11.7		

Table 2: 2: Changes in the mean arterial pressure before, during and after hemodialysis

The MAP reduced from T1 to T2 from 112.8+/-12.4 mm Hg to 109.0+/-11.6 mm Hg with mean reduction of 3.8+/-1.8 mm Hg. The DBP increased from T2 to T3 from 109.0+/-11.6 mm Hg to 111.2+/-11.7 mm Hg with mean increase of 2.2+/-2.4 mm Hg. The T3 MAP, 30 min after the end hemodialysis have not reached the pre-hemodialysis level, from T1 to T3 there is mean decrease of 1.6+/-2.6 mm Hg. These variations were not found to be statistically significant. Table 2

Time	Mean arterial pressure (mmHg)	
	Right eye	Left eye
T1	15.7+/-2.5	15.7+/-2.1
T2	19.7+/-3.0	19.8+/-2.9
T3	16.8+/-2.7	16.6+/-2.1
F value	**56.8323**	**80.8474**
P value	**< 0.0001**	**< 0.0001**

Table 3: Changes in the intra-ocular pressure before, during and after hemodialysis

The RE IOP increased from T1 to T2, 15.7+/-2.5 mm Hg to 19.7+/-3.0 mm Hg with mean increase of 4.2+/-1.7 mm Hg. The IOP decreased from T2 to T3 from 19.7+/-3.0 mm Hg to 16.8+/-2.7 mm Hg with mean decrease of 2.9+/-2.3 mm Hg. The T3 IOP, 30 min after the end hemodialysis have increased when compared to the pre-hemodialysis level, from T1 to T3 there is mean increase of 1.1+/-1.5 mm Hg. The LE IOP increased from T1 to T2, 15.7+/-2.1 mm Hg to 19.8+/-2.9 mm Hg with mean increase of 4.1+/-1.7 mm Hg. The IOP decreased from T2 to T3, 19.8+/-2.9 mm Hg to 16.6+/-2.1 mm Hg with mean decrease of 3.2+/-2.1 mm Hg. The T3 IOP, 30 min after the end hemodialysis have increased when compared to the pre-hemodialysis level, from T1 to T3 there is mean increase of 0.9+/-1.3 mm Hg. All these variations in both the eyes were found to be statistically significant.Table 3

Time	Systolic blood pressure (mmHg)	F value	P value
T1	156.2+/-17.3		
T2	151.4+/-16.6	2.042	0.1315
T3	154.4+/-17.0		
Time	**Diastolic blood pressure (mmHg)**	**F value**	**P value**
T1	91.0+/-11.3		
T2	87.7+/-10.6	2.375	0.09447
T3	89.8+/-10.5		

Table 1: Changes in the systolic and diastolic blood pressure before, during and after hemodialysis

Time	Mean ocular perfusion pressure	
	Right eye	Left eye
T1	59+/-8.4	59.1+/-8.6
T2	52.7+/-8.1	52.7+/-81
T3	57.3+/-7.5	57.6+/-8.1
F value	**16.5627**	**16.3807**
P value	**< 0.0001**	**< 0.0001**

Table 4: Changes in the mean ocular perfusionpressure before, during and after hemodialysis

The MOPP of RE has decreased from T1 to T2, 59.0+/-8.4 mmHg to 52.7+/-8.1 mm Hg and increased from T2 to T3, 52.7+/-7.5 mm Hg to 57.3+/-7.5 mm Hg. The mean decrease of MOPP from T1 to T3was by 1.8+/-3.0 mm Hg. Similar findings were found in left eye. All these variations in both the eyes were found to be statistically significant.Table 4

DISCUSSION

58 patients were male and 42 patients were female.There has been varying conclusions made by different authors in their studies in the past. The various results were IOP rise during or after hemodialysis, IOP decrease during hemodialysis; and finally in some no change in IOP was found.

A study conducted by Hu J et al. [6] showed that pre to post-hemodialysis, IOP significantly increased by 3.1 mm Hg in both eyes with p = 0.001. MAP significantly decreased by 5.8 mm Hg, with p<0.05. 63% of the right eyes (31 of 49) and 65% of the left eyes (31 of 48) had a MOPP of 42 mm Hg or less. Measurements were made with the patient in a seated position approximately 15 minutes before starting HD (T1), approximately 2 hours after starting HD (T2), and approximately 15 minutes after ending HD (T3) by pneumatonometer.

Wang L et al. [7]concluded that IOP increased from 16.87 mm Hg pre-hemodialysis to 17.24mmHg during hemodialysis, at 30 min after hemodialysis IOP was 17.42mmHg which was measured by handheld rebound tonometer.SBP decreased significantly after two hour of hemodialysis by 12mmHg with p< 0.05 then returned to its pre-HD levels within 30 min after hemodialysis (P > 0.05).

There was significant decrease in MOPP pre-hemodialysis to during hemodialysis from 53.75+7.8 mm Hg to 50.67+9.89 mmHg. There was rise of MOPP from 50.67+9.89 mm Hg to 55.23+9.73 mm Hg post-hemodialysis. [8]

In this study there is spike of IOP by 4.15+/-1.7 mm Hg and drop in MAP by 3.8+/-1.8 mmHg and MOPP by 6.35+/-2.57 mm Hg during hemodialysis. There is decrease in IOP by 3+/-2.2 mm Hg, increase in MAP by 2.2+/-2.4 mm Hg and MOPP by 4.7+/-2.8 mm Hg from during hemodialysis to 30 minutes after hemodialysis. T3 IOP is still higher than the pre-hemodialysis IOP. T3 MAP and MOPP are lower than pre-hemodialysis level, which is statistically significant. This variation in post hemodialysis levels may be due to the duration after which T3 values were measured, in this study it was 30 minutes and different instruments used for measuring IOP and position while measuring IOP. There is corneal stromal dehydration post-hemodialysis leading to decreased corneal thickness, so there will be false lower IOP measured by the indentation tonometer which is not taken into consideration.

According to Watson SG et al. [9], there is 0.21 mm Hg higher IOP for every 10 mm Hg higher SBP. [10]But link between hypertension and POAG is not established. With recent reviews favoring more important role of hypotension. In this study with reduction of SBP by 4.8 mm Hg and DBP by 3.3 mm Hg during hemodialysis there in reduced MAP by 3.8 mm Hg favoring onset and progression of optic nerve damage by reducing tissue perfusion.

During hemodialysis, ultrafiltration component of aqueous humor is affected. [10–14]There is rapid decrease in plasma osmolarity, relative increase in concentration of urea in aqueous humor during hemodialysis. This results in shift of fluid from vascular compartment to anterior chamber, which leads to increase in aqueous humor production when compared to outflow leading to increased IOP during hemodialysis. Patients not having glaucoma, those who have glaucoma but well controlled with medications or filtering surgery can accommodate the rise in IOP. But in patients with eye-outflow obstruction due to anterior synechiae or narrow anterior chamber angle and in patients vulnerable for optic nerve damage, rise in intraocular pressure and insult to optic nerve during hemodialysis may be significant.

There is fall in MAP and rise in IOP and hence there is fall in MOPP during dialysis. When MOPP is less than 50 mm Hg, auto regulation can no longer compensate. This vascular dysregulation leads to abnormal ocular perfusion and optic nerve head ischemia, exacerbating optic nerve head damage. In this study 30% of patient is having MOPP of < 50 mm Hg during hemodialysis. Adequate oxygenation of ocular tissues depends on maintenance of Ocular Perfusion Pressure through systemic regulation of Blood Pressure.

There is decrease in urea concentration and osmolarity in CSF also but the change is slower than blood. These causes shift of fluid from blood into CSF and rise in CSF pressure, also known as dialysis-disequilibrium syndrome. [15] Burn concluded that IOP rise during HD is thought to be part of cerebral edema. [16]

LIMITATIONS OF STUDY:

Schiotz tonometer was used for measurement of IOP. Factors affecting IOP measured by Schiotz tonometer like steep cornea, thick cornea, scleral rigidity is not taken into consideration. As it is a cross-sectional study, follow-up of patients and degree of insult caused on optic nerve by raise in IOP in subsequent dialysis could not be assessed.

CONCLUSION:

Significant fluctuations were seen from the present study in the intra-ocular pressure and mean ocular perfusion pressure during, before and after hemodialysis. If there are greater fluctuations in IOP during hemodialysis, frequent eye examinations and visual field tests should be done to monitor the disease progression closely and reduce the number and duration of hemodialysis sessions to as minimum as possible.

Financial support and sponsorship: Nil.

REFERENCES

1. Swarnalatha G, Ram R, Prasad N, Dakshinamurty K. End stage renal disease patients on hemodialysis: A study from tertiary care centre in a developing country. Hemodial Int. 2011;15:312–319.
2. Chelala E, Dirani A, Fadlallah A. Effect of hemodialysis on visual acuity, IOP, macular thickeness in patients with CKD. Clinical Ophthalmol. 2015;9:109–114.
3. Wang YX, Xu L, Wei WB, Jonas JB. Intraocular pressure and its normal range adjusted for ocular and systemic parameters. The Beijing Eye Study 2011. PLoS One. 2011;13:196926–196926.
4. Pressure IO, Tonometry. Shields Textbook of Glaucoma. Wolters Kluwer ; 2019,. p. 24–25.
5. Pressure IO, Tonometry. Shields Textbook of Glaucoma. Wolters Kluwer ; 2019,. p. 28–29.
6. Hu J, Bui KM, Patel KH. Effect of Hemodialysis on Intraocular Pressure and Ocular Perfusion Pressure. JAMA Ophthalmol. 2013;131(12):1525–1531.
7. Wang L, Yin G, Yu Z, Chen N, Wang D. Effect of Hemodialysis on Eye Coats, Axial Length, and Ocular Perfusion Pressure in Patients with Chronic Renal Failure. J Ophthalmol. 2018;p. 3105138–3105138.
8. Sitprija V, Holmes JH, Ellis PP. Changes in intraocular pressure during hemodialysis. Invest Ophthalmol Vis Sci. 1964;3:273–283.
9. Watson SG, Greenwood WR. Studies on the intraocular pressure during hemodialysis. Can J Ophthalmol. 1966;1:301–307.
10. Klein BE, Klein R, Knudtson MD. Intraocular pressure and systemic blood pressure: longitudinal perspective: the Beaver Dam Eye Study. Br J Ophthalmol. 2005;89(3):284–287.
11. Tawara A, Kobata H, Fujisawa K, Abe T, Ohnishi Y. Mechanism of intraocular pressure elevation during hemodialysis. Curr Eye Res. 1998;17:339–347.
12. Gutmann SM, Vaziri ND. Effect of hemodialysis on intraocular pressure. Artif Organs. 1984;8:62–65.
13. Ramsell JR, Ellis PP, Paterson CA. Intraocular pressure changes during hemodialysis. Am J Ophthalmol. 1971;72:926–930.
14. Watson SG, Greenwood WR. Studies on the intraocular pressure during hemodialysis. Can J Ophthalmol. 1966;1:301–307.
15. Leiba H, Oliver M, Shimshoni M, Bar-Khayim Y. Intraocular pressure fluctuations during regular hemodialysis and ultrafiltration. Acta Ophthalmol (Copenh). 1990;68:320–322.
16. Burn RA. Intraocular pressure during hemodialysis. Br J Ophthalmol. 1973;57:511–513.

How to cite this article: Seethalakshmi D, Kanakapur S, DK S. **A study of changes in Mean Ocular Perfusion Pressure and Intra-Ocular Pressure among patients undergoing hemodialysis**. Perspectives in Medical

Research. 2022;10(2):21-25
DOI: 10.47799/pimr.1002.05