

## CORRELATION OF OCULAR PERFUSION PRESSURE AND INTRAOCULAR PRESSURE CHANGES DURING HAEMODIALYSIS IN END STAGE RENAL DISEASE- AN OBSERVATIONAL STUDY

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### ABSTRACT

#### BACKGROUND

Chronic kidney disease patients on haemodialysis have a transient raise in intraocular pressure and decrease in ocular perfusion pressure. This is used in early detection of glaucomatous optic nerve damage and subsequent irreversible visual loss.

#### MATERIALS AND METHODS

100 chronic kidney disease patients under haemodialysis in the nephrology department, Stanley medical college for more than one month were included in the study. We recorded complete history, and all participants were subjected to Intraocular pressure and blood pressure measurement at 3 different timings during haemodialysis session. Mean Arterial Pressure (MAP), Ocular Perfusion Pressure (OPP), Systolic Ocular Perfusion Pressure (SOPP), Diastolic Ocular Perfusion Pressure (DOPP) and Mean Ocular Perfusion Pressure (MOPP) were calculated.

#### RESULTS

Mean IOP from the initiation to the end of haemodialysis was found to be increased. Mean arterial pressure, ocular perfusion pressure, systolic ocular perfusion pressure, diastolic ocular perfusion pressure, mean ocular perfusion pressure was found to be decreased from the initiation to the end of haemodialysis. At the end of study period, 10% were found to develop early glaucomatous field defects and early optic nerve head changes in both eyes at follow-up.

#### CONCLUSION

Our study reveals the importance of screening and monitoring of intraocular pressure and characteristic early optic nerve head changes and early visual field changes of glaucoma in end-stage renal disease patients who are on haemodialysis.

#### KEYWORDS

Intra Ocular Pressure, Ocular Perfusion Pressure, Haemodialysis, Glaucoma.

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#### BACKGROUND

Chronic kidney disease (CKD) is a gradual progressive irreversible loss of renal function over a period of months or years. About 10% of the global population may be affected by CKD. The rise in chronic kidney disease patients is primarily due to ageing population, diabetes, hypertension, glomerulonephropathy.

Chronic kidney disease and its treatment haemodialysis (HD) may lead to ocular complaints or exacerbation of underlying ocular disease like elevated Intraocular pressure

(IOP), glaucoma, macular oedema, age-related macular degeneration, ischemic optic neuropathy. Glaucoma is a chronic progressive optic neuropathy caused by a group of ocular conditions which lead to damage of optic nerve with visual field defects.<sup>1</sup> Increase in intraocular pressure which is the most common risk factor and an only treatable parameter of glaucoma.<sup>2</sup> During haemodialysis changes in haemoconcentration, plasma colloid-osmotic pressure, plasma osmolarity during HD could be registered.<sup>3</sup> It is important to reveal their influence on ocular perfusion pressure and intraocular pressure.

Chronic kidney disease patients on haemodialysis are found to have a transient increase in intraocular pressure and decrease in ocular perfusion pressure during haemodialysis.<sup>4</sup> Hence it necessitates to monitor IOP & OPP for these patients as a routine during haemodialysis session and also during a routine examination of CKD patients who are on haemodialysis.<sup>5</sup> This may help in early detection of elevation and fluctuation of IOP & OPP and also in early detection of glaucomatous optic nerve damage and

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subsequent irreversible visual loss.<sup>6</sup> It also helps in early intervention in order to prevent the progression of the disease

**Aims and Objectives**

1. To assess the correlation of intraocular pressure changes during haemodialysis.
2. To assess the correlation of ocular perfusion pressure changes during haemodialysis.
3. To determine that the screening for intraocular pressure and characteristic optic nerve head changes and visual field changes of glaucoma in end-stage renal disease patients under haemodialysis is reasonable and justifiable.

**MATERIALS AND METHODS**

This study was performed on 100 Chronic Kidney Disease (stage V) patients under haemodialysis treatment, who are attending our Dialysis unit in Nephrology Department, Govt. Stanley Medical College, Chennai for more than one month were included in this study.

A detailed medical, haemodialysis and ocular history was collected from all the participants and they underwent a thorough physical examination, relevant laboratory tests regarding chronic kidney disease and complete ocular examinations.

All participants are subjected to intraocular pressure measurement by using Schiottz tonometry and Blood pressure measurement using sphygmomanometer on the upper arm over the brachial artery at three different times during haemodialysis session. Dialysis was performed with session durations of 3 to 5 hours.

- T1 - 15 minutes before initiation of haemodialysis.
- T2 - 2 hours after initiation of haemodialysis.
- T3 -15 minutes after ending haemodialysis.

Mean Arterial Pressure (MAP), Ocular Perfusion Pressure (OPP), Systolic Ocular Perfusion Pressure (SOPP), Diastolic Ocular Perfusion Pressure (DOPP) and Mean Ocular Perfusion Pressure (MOPP) were calculated.

**The following formulas will be used to calculate at each time point.<sup>7</sup>**

- Mean arterial pressure (MAP)  
 $MAP = Diastolic\ BP + 1/3 (Systolic\ BP - Diastolic\ BP)$
- Ocular perfusion pressure (OPP)  
 $OPP = MAP - IOP$   
 $SOPP = Systolic\ BP - IOP$   
 $DOPP = Diastolic\ BP - IOP$   
 $MOPP = 2/3(MAP - IOP).$

**Inclusion Criteria**

Chronic kidney disease (stage V) patients who are receiving haemodialysis therapy for  $\geq 1$  month at Dialysis Unit.

**Exclusion Criteria**

1. Patients with pre-existing corneal abnormality.
2. Patients with ocular infection.
3. Patients with glaucoma, narrow angles.

4. Patients with high myopia.
5. Patients with other ocular diseases, dense cataract, opaque media.

**RESULTS**

Mean IOP from the initiation to the end of haemodialysis was found to be increased by 2.7 mm Hg in both eyes. It was found to be statistically significant (RE p- value: 0.000, LE p-value 0.000).

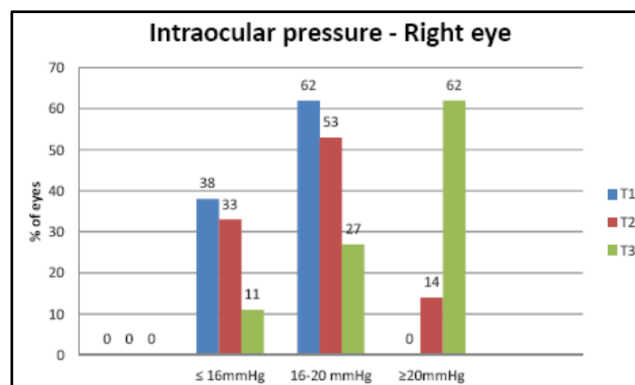


Figure 1

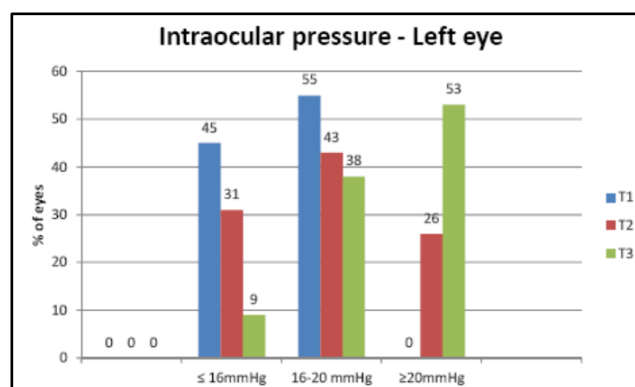


Figure 2

Mean arterial pressure (MAP) from the initiation to the end of haemodialysis was found to be decreased by 10.13 mm Hg. It was found to be statistically significant (p- value: 0.000).

Ocular perfusion pressure from the initiation to the end of haemodialysis was found to be decreased by 12.84 mm Hg in both eyes. It was found to be statistically significant (RE p- value: 0.000, LE p-value 0.000).

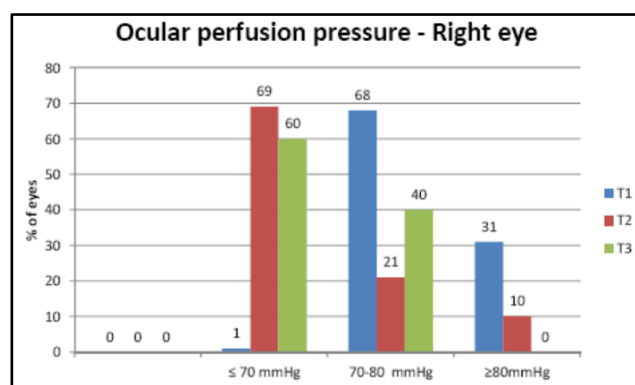


Figure 3

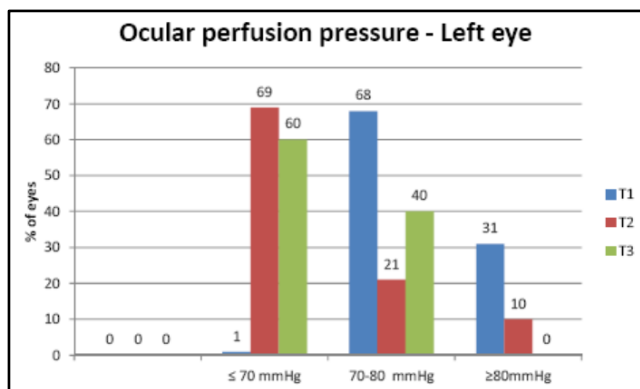


Figure 4

Systolic ocular perfusion pressure from the initiation to the end of haemodialysis was found to be decreased by 13.92 mm Hg in both eyes. It was found to be statistically significant (RE p- value: 0.000, LE p-value 0.000).

Diastolic ocular perfusion pressure from the initiation to the end of haemodialysis was found to be decreased by 12.016 mm Hg in both eyes. It was found to be statistically significant (RE p- value: .0.000, LE p-value 0.000).

Mean ocular perfusion pressure from the initiation to the end of haemodialysis was found to be decreased by 8.59 mm Hg in both eyes. It was found to be statistically significant (RE p- value: 0.000, LE p-value 0.000).

Applying the thresholds used in the Barbados eye studies for evaluating relative risk of open angle glaucoma development and progression.

- 58% of both eyes had a Systolic ocular perfusion pressure of ≤101 mmHg
- 58% of both eyes had a Diastolic ocular perfusion pressure of ≤55 mmHg
- 48% both eyes had a Mean ocular perfusion pressure of ≤42 mmHg.

Patients were asked for follow-up based on their findings.

Among the 100 patients, 58 patients had Ocular perfusion pressure (OPP, MOPP, SOPP, DOPP) below baseline at their first visit examination. Hence, they were followed up every 3 months.

Among 58 patients advised follow-up, 46 attended regular follow-up of maximum 3 visits every 3 months during our study period. They underwent the needed ocular and systemic examinations in all the 3 visits and the results were compared.

12 Patients did not attend complete follow-up as per advice. In these 12 patients 2 patients had early field changes and optic nerve head changes but we lost follow up of the min following visits.

At the end of this 2-year period, 4 of the 46 patients were found to develop early glaucomatous field defects and early optic nerve head changes in both eyes at follow-up visits compared to normal fields and optic nerve head in their initial visits. They were also found to have increased in intraocular pressure (≥ 21 mmHg in both eyes) compared to the initial reading.

## DISCUSSION

Our study reveals statistically significant increase in intraocular pressure during haemodialysis. Our study also reveals that there is statistically significant decrease in ocular perfusion pressure, diastolic ocular perfusion pressure, systolic ocular perfusion pressure and mean ocular perfusion pressure during haemodialysis.

The reason behind raise in IOP during haemodialysis has been explained as an effect secondary to a rapid decrease in plasma osmolarity and a relative increase in intracellular compared with extracellular urea concentration. This rapid change results in a gradient between plasma and ocular compartments, inducing a shift of extracellular fluid from the blood to the anterior chamber. And also increase in IOP is more pronounced in eyes with compromised aqueous outflow.<sup>8</sup>

The evidence is increasing that IOP and BP instability may be associated with glaucoma. Variations in ocular perfusion pressure due to IOP and BP fluctuations may play a role in glaucoma development or progression.

### Reasons of ocular perfusion pressure fluctuation during haemodialysis session are as follows.<sup>9,10</sup>

- Autoregulation, the ability of vascular bed to change the vascular resistance in response to the perfusion pressure changes to maintain a relatively constant blood flow- plays a crucial role if undergoes impairment.
- Fluctuation changes of BP secondary to fluid shifts during active process of haemodialysis.

Our study found that there is statistically significant fluctuation in ocular perfusion pressure during a haemodialysis session. Accordingly, haemodialysis patients might have frequent IOP and OPP fluctuations during long-term, frequent sessions of haemodialysis, each lasting several hours may subsequently increase patients risk for glaucoma development and progression.

Survival rates of haemodialysis patients have been studied which showed that there is an improvement in life expectancy of end-stage renal disease patients after haemodialysis initiation. Hence it is important to screen as well as monitor the intraocular pressure, early optic nerve head changes and record the early visual field defects of glaucoma in end stage renal disease patients on haemodialysis.

## CONCLUSION

Glaucoma is one of the preventable causes of irreversible visual impairment, on diagnosis and treatment at early stages. Intraocular pressure and Ocular perfusion pressure has been shown to be known risk factors for open angle glaucoma.

The evidence is increasing that IOP, BP and ocular perfusion pressure instability may be associated with glaucoma. Variations in ocular perfusion pressure due to IOP and BP fluctuations may play a role in glaucoma development or progression. Transient changes in

intraocular pressure and ocular perfusion pressure during haemodialysis has been studied only by few studies.

Our study found that there is transient increase in intraocular pressure to around 3 mmHg during haemodialysis and transient decrease in ocular perfusion pressure during haemodialysis. At the end of this 2-year study period, 6 of the 58 patients were found to develop early glaucomatous field defects and early optic nerve head changes in both eyes at follow-up visits compared to normal fields and optic nerve head in their initial visits, which comes around 10%.

This study will help in better management of known glaucoma patients when they require haemodialysis. That way the impending ischemic insult of the optic nerve head can be avoided.

Chronic kidney disease patients with diabetes mellitus, systemic hypertension, glaucoma suspects, family history of glaucoma may benefit from intraocular pressure and blood pressure monitoring during a haemodialysis session.

Hence monitoring of intraocular pressure and screening for early optic nerve head changes and early visual field defects is mandatory in end-stage renal disease patients on haemodialysis. So, doing a routine screening of IOP and glaucoma changes before initiation of haemodialysis therapy is reasonable and justifiable.

#### REFERENCES

- [1] Stomper RL, Lieberman M, Drake M. *Becker-Shaffer's diagnosis and therapy of the glaucomas*. 8<sup>th</sup> edn. Mosby 2009:47-61.
- [2] Bowling B. *Kanski's Clinical ophthalmology*. 8<sup>th</sup> edn. Elsevier 2016:306-309.
- [3] Eid TM, Spaeth GL. *The glaucomas – concepts and fundamentals*. Philadelphia, London: Lippincott Williams and Wilkins 2000:21-26.
- [4] Tawara A, Kobata H, Fujisawa K, et al. Mechanism of intraocular pressure elevation during hemodialysis. *Curr Eye Res* 1998;17(4):339-347.
- [5] Burn RA. Intraocular pressure during hemodialysis. *Br J Ophthalmol* 1973;57(7):511-513.
- [6] Liang Y, Downs JC, Fortune B, et al. Impact of systemic blood pressure on the relationship between intraocular pressure and blood flow in the optic nerve head of non-human primates. *Invest Ophthalmol Vis Sci* 2009;50(5):2154-2160.
- [7] Zheng Y, Wong TY, Mitchell P, et al. Distribution of ocular perfusion Pressure and its relationship with open-angle glaucoma: the Singapore malay eye study. *Invest Ophthalmol Vis Sci* 2010;51(7):3399-3404.
- [8] Cecchin E, De Marchi S, Tesio F. Intraocular pressure and hemodialysis. *Nephron* 1986;43:73-74.
- [9] Memarzadeh F, Ying-Lai M, Chung J, et al. Blood pressure, perfusion pressure and open-angle glaucoma: the Los Angeles Latino Eye Study. *Invest Ophthalmol Vis Sci* 2010;51(6):2872-2877.
- [10] Tokuyama T, Ikeda T, Sato K. Effect of plasma colloid osmotic pressure on intraocular pressure during haemodialysis. *Br J Ophthalmol* 1998;82(7): 751-753.