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Evaluation of intraocular pressure and ocular perfusion pressure during hemodialysis

Avaliação da pressão intraocular e da pressão de perfusão ocular durante a hemodiálise

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Abstract

Objective: *To evaluate the variation of intraocular pressure and ocular perfusion pressure during hemodialysis sessions, in the pre, intra (hourly) and post dialytic periods, in patients treated at Hemodialysis Reference Services in Fortaleza - CE.* ***Methods:*** *The study was longitudinal and prospective. 45 patients underwent hemodialysis. All patients were recruited to undergo an ophthalmologic examination, in addition to the intraocular pressure measurement with Tonopen.* ***Results:*** *The sample consisted of 26 men and 19 women with a mean age of 51.8 years. The study revealed that there is an important difference between pre and post hemodialysis intraocular pressure, decreasing by an average of 2.59 mmHg. When analyzing ocular perfusion pressure, an average increase of 1.85 mmHg was found between the onset and end of hemodialysis.* ***Conclusion:*** *According to the present study, the hemodialysis process is an apparently safe procedure in relation to altered intraocular pressure and ocular perfusion pressure, as causes of ocular pathologies, mainly glaucoma.*

Keywords: *Intraocular pressure; Arterial pressure; Tonometry, ocular; Renal dialysis; Eye health*

Resumo

Objetivo: Avaliar a variação da pressão intraocular e da pressão de perfusão ocular durante sessão de hemodiálise, nos períodos pré, intra (a cada hora) e pós dialítico, em pacientes tratados em Serviços de Referência em hemodiálise da cidade de Fortaleza - CE. **Métodos:** O estudo foi longitudinal e prospectivo. 45 pacientes foram submetidos à hemodiálise. Todos os pacientes foram recrutados a fazer um exame oftalmológico, além da aferição da pressão intraocular com o Tonopen. **Resultados:** A amostra foi composta por 26 homens e 19 mulheres com idade média de 51,8 anos. O estudo revelou que há uma diferença importante entre a pressão intraocular pré e pós hemodiálise, diminuindo em média 2,59 mmHg. Ao analisar a pressão de perfusão ocular, foi encontrado um aumento médio de 1,85 mmHg entre o início e o término da hemodiálise. **Conclusão:** De acordo com o presente estudo, o processo de hemodiálise é um procedimento aparentemente seguro em relação à alteração da pressão intraocular e da pressão de perfusão ocular, como causadores de patologias oculares, principalmente o glaucoma.

Descritores: Pressão intraocular; Pressão arterial; Tonometria ocular; Diálise renal; Saúde ocular

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Introduction

Hemodialysis (HD) consists of removing fluid and toxic substances from the blood, filtering and purifying the undesirable contents.[1] This procedure increases the survival of patients with renal disorders who come to live with their adverse effects on the various systems of the organism. [2,3]

A hipotensão arterial ainda representa uma das principais complicações resultantes da HD, que, frequentemente, encurta o tempo de diálise e aumenta a taxa de mortalidade dos pacientes.[4,5] The pathogenesis of hemodynamic instability in response to fluid withdrawal probably involves many factors, including: an imbalance between endothelin, nitric oxide synthesis, and the adjustment of some arteriovenous alterations in response to changes in plasma volume.[6] This instability can cause eye changes, such as: anterior ischemic optic neuropathy, alterations in the intraocular pressure (IOP) and ocular perfusion pressure (OPP).[7]

Os mecanismos que levam às alterações da PIO na pré, intra e pós terapia dialítica ainda hoje são controversos.[8] Some authors suggest that the increase in IOP may be the result of an alteration in the colloid osmotic pressure of the plasma, resulting a rapid drop in osmolarity with subsequent increase in aqueous formation, a mechanism analogous to cerebral edema occuring in the imbalance syndrome.[9,10] There is conflicting evidence on the influence of osmolality decrease rate on induction of IOP increase during HD. In addition, some authors did not find statistically significant differences in IOP before or after HD, even if osmolality changes were present.[6] While others suggest that decreased drainage of the aqueous humor may be the mechanism of increased intradialytic IOP, since most patients who had elevated this parameter during HD also had a shallow anterior chamber angle.[11]

The objective of the present study was to investigate IOP and OPP in patients in the various stages of renal disease during HD in a population treated at two reference centers in HD, evaluating the oscillations in the pressure, the moment they occur during dialysis, and the relation between the amount of fluid lost and the alterations in IOP.

Methods

It is a longitudinal prospective study carried out between August 2014 and February 2015. The study was carried out at two HD centers (Prontorim and Instituto do Rim) and at a reference hospital in ophthalmology (Hospital de olhos Leiria de Andrade) located in the city of Fortaleza - CE.

The project was approved by the research ethics committee of the Centro Universitário Christus under protocol 30552214.6.0000.5049. All the ethical principles governing research with human beings were respected and defined in Decree 466/12 of CNS/Ministry of Health - MS, which regulates research on human beings. All patients who agreed to be part of the study signed the Informed Consent Term.

Patients who had been on HD for at least a year were included. Patients with a diagnosis of glaucoma, patients with hypertensive crisis during the procedure, iridotomy, trabeculectomy, trabeculotomy or any ophthalmological disease that may affect IOP assessment were excluded.

All patients underwent an initial ophthalmologic examination (visual acuity with a Snellen table at 6m, slit-lamp biomicroscopy evaluating the anterior chamber, its depth, funduscopy with indirect binocular ophthalmoscope and 20D Volk lenses; IOP with the Goldmann Tonometer) before setting the HD date.

On the day the HD was performed, the weight was measured at the beginning and end of the session for comparison and determination of the fluid loss hourly, to correlate it later on with the IOP, and to observe how was the relation between them. The IOP was evaluated with Tonopen (Tonopen Avia, Reichert Inc., USA) at the beginning and hourly until the end of the session for more detailed monitoring of the variation of these values. OPP was estimated by measuring the difference between 2/3 of average blood pressure (BP) and IOP values. BP was checked before, every hour and at the end of the procedure.

Data regarding the sociodemographic and clinical aspects of the sample on the day of HD (age, gender, time and cause of HD, amount of fluid loss, systolic and diastolic BP and OPP) was collected.

Statistical analysis was performed using SPSS 16.0 software (SPSS Inc. Chicago, IL, USA). Standard descriptive analyzes were elaborated, such as calculation of central trend measures for numerical variables and frequency distribution for categorical data. The Pearson's correlation was applied to the numerical variables selected, and the Student's t-test for independent samples for comparison. A value of $p < 0.05$ was considered statistically significant.

Results

The sample consisted of 45 patients, 26 (57.8%) males and 19 (42.2%) females. The average age was 51.8 years (standard deviation = 14.5, minimum = 14, maximum = 83).

The main primary renal diseases were: hypertension (42.9%), diabetes mellitus (11.9%), kidney stones (4.8%), and polycystic kidneys (4.8%). Regarding the cause of HD, 26 (59.1%) were renal failure, 6 (13.6%) hypertension, and 4 (9.1%) diabetes mellitus.

Among the patients evaluated, 18 (40.0%) had some ophthalmological disease. The most common diseases were: myopia (41.2%), cataract (23.5%), diabetic retinopathy (17.6%), and 17 (37.8%) had altered visual acuity.

The average values of arterial, intraocular and ocular perfusion pressures are presented in Table 1.

Figure 1 demonstrates the variation of IOP and OPP throughout the HD for the right and left eyes.

The average Δ weight was -1.41 (standard deviation = 1.3, minimum = 4, maximum = 0).

The IOP during HD was higher in females ($p < 0.005$).

Figure 2 shows the variation of OPP according to gender during the HD session.

Table 2 shows the variation and correction between IOP and OPP measures in the right and left eyes.

Age was inversely proportional to the OPP of the right eye, IOP of the right eye and IOP of the left eye. However, it was directly proportional to the OPP of the left eye.

The patients studied had for the most part HD with constant net loss every hour. Correlating it to the variable weight, the variation found was -1.41, with the standard deviation of 1.3.

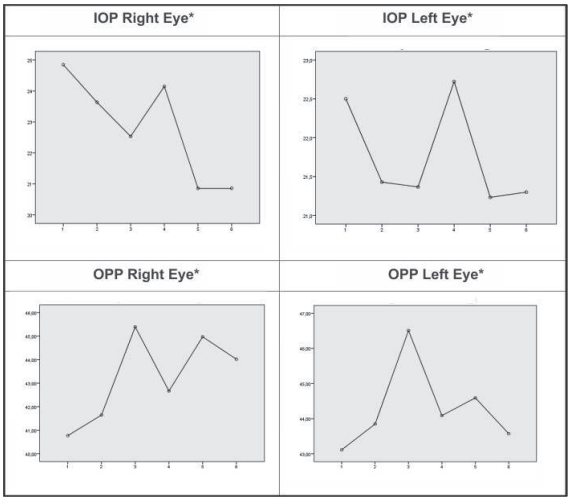
Table 1
Average and standard deviation of BP, IOP, OPP and weight at different times

Variable	PAS	PAD	Average BP	IOP RE	IOP LE	OPP RE	OPP LE
			Pre-HD				
Average	138.64	78.31	98.42	24.84	22.50	40.77	43.11
Standard Deviation	26.04	17.90	16.79	8.65	6.79	12.61	11.37
			During HD - 1ª hora				
Average	139.49	77.13	97.92	23.63	21.43	41.65	43.85
Standard Deviation	21.34	12.02	13.31	8.00	6.28	11.34	11.62
			During HD - 2ª hora				
Average	146.04	78.82	101.23	22.53	21.37	45.39	46.51
Standard Deviation	24.57	12.01	14.78	6.36	6.14	10.30	11.35
			During HD - 3ª hora				
Average	143.11	78.02	99.72	24.14	22.72	42.67	44.09
Standard Deviation	23.03	11.49	13.33	6.74	5.83	10.90	10.82
			During HD - 4ª hora				
Average	140.67	77.78	98.74	20.86	21.23	44.97	44.59
Standard Deviation	24.86	14.49	13.33	6.74	5.83	10.90	10.82
			Post-HD				
Average	135.76	78.09	97.31	20.86	21.30	44.02	43.57
Standard Deviation	23.15	11.74	13.19	5.77	4.75	10.62	9.93

Table 2:
Pearson's R-values of correlations between IOP and OPP measures

		Delta_IOP R	Delta_IOP L	Delta_OPP R	Delta OPP L
Delta_IOP R	Pearson Correlation	1	0.616**	0.477**	- 0.144
	Sig. (2-tailed)		0,000	0.001	0.345
Delta_IOP L	Pearson Correlation	0.616**	1	- 0.009	0.377*
	Sig. (2-tailed)	0.000		0.953	0.011
Delta_OPP R	Pearson Correlation	0.477**	-0.009	1	0.332*
	Sig. (2-tailed)	0.001	0.953		0.026
Delta OPP L	Pearson Correlation	0.345	0.011	0.026	1
	Sig. (2-tailed)	0.345	0.011	0.026	

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).



*p < 0,001

Figure 1: IOP and OPP trend over hemodialysis in relation to the eye evaluated.

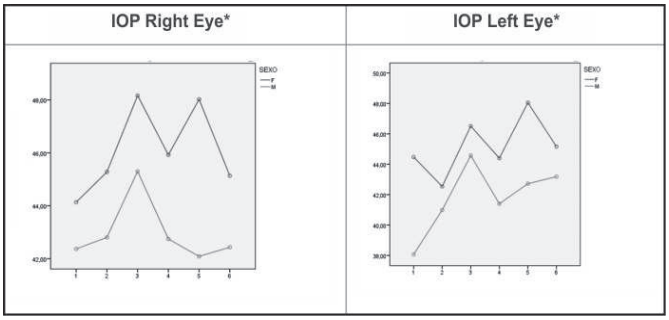


Figure 2: Variation of OPP according to gender during the HD session

Discussion

Currently, the concept of IOP and OPP and the identification of these altered measures for risk of development and progression of glaucoma bring together vascular and mechanical components in their theory. We believe that altering the balance between IOP

and BP determines whether or not an individual will develop damage to his or her optic disc.[8]

Risk factors correlated with elevated IOP include: old age, black people, positive family history, and some concomitant ophthalmological diseases. Systemic arterial hypertension and the presence of vascular diseases have been proposed as risk factors, but current data is still controversial.[12,13]

Some authors suggest that patients with glaucoma and an exaggerated night reduction of systemic BP have altered OPP outside the period of BP reduction, and even if they do HD, they do not correlate the alterations to the procedure, but instead to the deregulation of the vascular system.[14]

Em adição às alterações da PA, cita-se o ritmo circadiano em que se observa uma queda noturna que, também, é visualizada em algumas situações durante a HD, em que é notada uma redução no valor médio da PA.[8] Therefore, hypotension may occur during HD and be correlated to the IOP values. Therefore, some studies have been performed in recent years, and they showed that the IOP reduced significantly during HD. [15–17]

Em relação à doença glaucomatosa, há estudos que especulam que a PIO em pacientes com glaucoma durante a HD iria aumentar devido à drenagem ocular prejudicada ou à auto regulação anormal que, em grande parte, não são bem elucidadas.[12,18,19] However, as patients with glaucoma were excluded from the study, such correlation was not analyzed.

The present study demonstrated that systolic BP tended to increase at the 2nd, 3rd and 4th hour, with a decrease after the HD session. The diastolic BP had a very small variation, being between 78/79 mmHg before, during and after the procedure. Regarding the IOP, taking into consideration the reference value of normality between 10 and 20 mmHg, it was observed that the values in the right eye were higher in the pre-HD period, and in the 1st, 2nd and 3rd hours of session, with a reduction in the 4th hour and in the post-HD period. Regarding the left eye, the measures varied in smaller amount, between 21 and 22 mmHg during all the measures. It differs from some studies in which no significant change in IOP or BP variation was demonstrated during the HD session(8), and reinforces more recent studies in which the IOP increased and the systolic BP values varied during the HD procedure, especially at the 2nd and 3rd hours.[20]

According to each case, physicians should be aware of the possibility of elevation of IOP during HD, and it should be observed when this alteration occurs in association with the intradialytic periods, preferably every hour after the beginning of the procedure, to be compared with the levels before the process. To date, the influence of HD on IOP is not well known, and has even recent conflicting results.[21]

Regarding OPP and comparing the right and left eyes, an increase in the variation was observed from the 2nd hour of the procedure, corroborating a study referring to the increase of OPP in the HD procedure in patients with renal disease, and also confirming that slightly more than 1/3 of renal patients in renal replacement therapy have altered visual acuity. [21] In the present study, this alteration was noted in 37.8% of the people evaluated.

The study revealed that there is an important difference between pre and post HD IOP, decreasing by an average of 2.59 mmHg, going against previous studies that stated the IOP increase and thus increased the possibility of developing and progressing glaucoma in the long term.[22] When analyzing the OPP, an average increase of 1.85 mmHg was found between the beginning and the end of the HD, not corroborating the previous studies.[22]

The most current IOP reduction findings during the HD process may be associated with new HD techniques that make the process slower, thus altering the osmolarity as well. In conclusion, in view of the results obtained with the present study, the HD process is an apparently safe procedure in relation to IOP and OPP alteration as causes of ocular pathologies, mainly glaucoma.

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