Original Paper

Monitoring of Intraocular Pressure and Its Correlation With Systemic Parameters Before and After Hemodialysis

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Introduction. End-stage renal disease and hemodialysis affect intraocular pressure (IOP). This study aimed to evaluate the effects of a one session of hemodialysis on IOP.
Materials and Methods. In this study, the IOP of 130 eyes of 65 hemodialysis patients (38 men and 27 women) was measured before and every 1 hour after the initiation of hemodialysis therapy. Patients with any glaucomatous conditions were excluded. Demographic information including age, gender, underling systemic or ocular diseases, hemodialysis duration and frequency, KT/V, and levels of blood pressure, body weight, blood urea, serum sodium, serum potassium, blood glucose before and after hemodialysis were recorded.
Results. The mean age of the patients was 60.3 ± 16.7 years. The mean predialysis and postdialysis IOPs were 13.50 ± 4.09 mm Hg and 12.73 ± 4.07 mm Hg, respectively ($P = .02$). The mean IOP at the first and second hours (12.32 mm Hg and 11.83 mm Hg, respectively) of hemodialysis were significantly lower than the mean predialysis IOP ($P < .001$ for each). In nondiabetics, the mean IOP significantly decreased after hemodialysis. The mean predialysis and postdialysis blood glucose levels were significantly different between diabetics and nondiabetics, but were not significant in each group of diabetics and nondiabetics. There was a significant inverse relationship between IOP and blood glucose changes after hemodialysis ($r = -0.180$, $P = .040$).
Conclusions. Increased blood glucose levels significantly decreases IOP in hemodialysis patients without glaucomatous features. Changes in other metabolic parameters do not affect IOP during hemodialysis.

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INTRODUCTION

End-stage renal disease (ESRD) is an important worldwide health and economic problem with increasing incidence and prevalence. End-stage renal disease imposes enormous costs to all societies. Patients with ESRD have low quality of life and high morbidity and mortality rates. The common initial symptoms are a variety of problems that include headache and visual disturbances, resulting from arterial hypertension.[1-3]

Hemodialysis and ESRD itself induce many effects on visual system. In patients with ESRD, 30 minutes after hemodialysis, a change in retinal vessels diameter observed by digital fundus processing. Continuous vascular insult may be responsible for brain, eye, and heart vascular accidents in these patients.[4] Measurements of foveal thickness by optical coherence tomography (OCT) in patients with type 2 diabetes mellitus and ESRD showed that hemodialysis fluids bath temperature and conductivity affects the foveal thickness.[5] In addition to retinopathy, ESRD induces some other ocular abnormalities such as conjunctival and corneal calcification.[6] Nongpiur and colleagues, in a large series consisted of 3280 individuals at the community level, found that the overall prevalence of chronic kidney disease was 27.9%, in whom the mean intraocular pressure (IOP) was significantly higher than that in the normal population, independent of age, diabetes mellitus, and glaucoma.[7]

Some authors believe that in hemodialysis patients, decreased serum osmolality and increased aqueous humor/vitreous volume by the mechanism of oncotic gradient result in IOP increase. While some other studies excluded this hypothesis. Hemodialysis may influence different aspects of visual system, such as the corneal thickness, angle or anterior chamber depth, or crystalline lens diameter by means of changes in serum osmolality or mineral concentration. In one study, IOP did not change significantly during dialysis, but anterior chamber depth decreased significantly during acetate, but not bicarbonate dialysis.[8] Pakdel and colleagues found in 58 hemodialysis patients a significant correlation between the mean serum phosphorus concentrations and IOP before dialysis.[9] In the study of Samsudin and coworkers performed on 49 patients undergoing hemodialysis, surprisingly, IOP decreased significantly in the eyes with occludable angles, but in nonoccludable angles, no significant changes were seen in all subgroups.[10]

The aim of this study was to evaluate which of the different serum metabolic parameters changes are more essential on IOP changes in patients without any underlying glaucomatous disorders during the hemodialysis sessions, the question that has not been yet responded in the similar studies.

METHODS AND MATERIALS

This cross-sectional study was carried out on 65 patients (130 eyes) with ESRD who were under conventional intermittent hemodialysis for at least 3 months in Mustafa Khomeini Hospital, Tehran. The patients were under regular conventional hemodialysis by low-flux dialysis membranes and bicarbonate-based dialysis solutions. The mean dialysis solution flow rates were 500 mL/min, and blood flow rates were between 200 mL/min and 250 mL/min. The participants were selected by the random numbers method. The study protocol was approved by the ethics committee of Shahed University, and the principles outlined in the Declaration of Helsinki were followed.

All the participants signed an informed consent and underwent a through ocular exam before the experience. The patients were excluded if they had unilateral or bilateral glaucoma or uveitis of any type, angle abnormalities such as anterior or posterior synechia, history of any surgical or medical intervention for glaucoma, and any corneal surface surgeries, irregularities or opacities that precluded for careful measurement of IOP by the ocular tonometer. Also, the blind or one-eyed patients and those who were unable to cooperate with the study protocol due to their adverse systemic conditions or did not give informed consent were excluded.

Demographic information, including age, gender, any underlying systemic and ocular diseases, surgeries, and hemodialysis duration and frequencies per week were recorded. Those factors influenced by hemodialysis, such as blood pressure, levels of the weights, serum sodium level, serum potassium level, blood urea, and blood sugar, were recorded before and after hemodialysis. Additionally, the KT/V values as a marker for dialysis performance were calculated after the sessions. Venous blood samples were obtained just before and 30 to 60 seconds after hemodialysis and the samples were sent to laboratory promptly. Meanwhile, blood pressure and IOP were measured every 1 hour during dialysis. Measuring of IOP was performed with high accuracy using a calibrated I care tonometer (Model TA01i, Icare, Espoo, Finland) with standard guides.

For feasibility, analyses of all data were taken into consideration as 130 eyes rather than of 65 left eyes and 65 right eyes. Collected data were analyzed using the SPSS software (Statistical Package for the Social Sciences, version 17.0, SPSS Inc, Chicago, Ill, USA). Visual acuity and IOP changes and their relationships with other variables were evaluated using the chi-square test, the paired *t* test, and the Spearman rank correlation test. *P* values less than .05 were considered significant.

RESULTS

Sixty-five patients (130 eyes) were included in this study. The mean age was 60.3 ± 16.7 years (range, 24 to 90 years). Thirty-eight of the patients were men (mean age, 57.0 ± 16.9 years) and 27 were women (mean age, 64.8 ± 15.5 years). Forty-one patents were younger than 70 years (26 men and 15 women) and 24 were 70 years and older (12 men and 12 women). Among the patients, 19 (10 men and 9 women) were diabetic. Frequency of hemodialysis was less than 3 session per week in 14 patients (3 men and 11 women) and 3 sessions and more in 51 patients (35 men and 16 women). Demographic information of the patients is shown in Table 1.

Laterality of the eyes (right or left) had no significant effect on the predialysis and postdialysis IOP values. The mean IOP after hemodialysis decreased by 0.77 mm Hg, as compared to the mean IOP before hemodialysis (12.73 ± 4.07 mm Hg versus 13.50 ± 4.09 mm Hg; *P* = .02). There were no significant relationships between the mean IOP of any genders and the underlying diseases before and after hemodialysis (Table 2).

The mean IOP levels in the first and second hour of hemodialysis (12.32 mm Hg and 11.83 mm Hg, respectively) were significantly lower than the mean predialysis IOP (*P* < .001 and *P* < .001, respectively). In addition, the mean IOP in the second hour of hemodialysis was still lower than that in the first hour of hemodialysis (*P* < .001).

The mean decreases in IOP after hemodialysis in nondiabetic and diabetic patients were 1.02 mm Hg and 0.13 mm Hg, respectively. Concerning, nondiabetic patients, there were no changes in 11, a decrease in 38, and an increase in 43 eyes in the IOPs after hemodialysis. Totally, in nondiabetics (but not in diabetics), the mean IOP significantly decreased after hemodialysis (*P* = .007).

Although the mean blood glucose levels were significantly different between diabetics and nondiabetics before hemodialysis (190.68 mg/dL and 129.50 mg/dL, respectively) and after hemodialysis (174.68 mg/dL and 137.78 mg/dL, respectively; *P* < .001 for both), these differences were not significant in each group (*P* = .07 and *P* = .10, respectively). The mean blood glucose levels increased in nondiabetics and decreased in diabetics after hemodialysis. Although the overall changes in the mean blood glucose levels were nonsignificant (*P* = .06), but there was a meaningful inverse relationship between IOP and blood glucose changes after hemodialysis (*P* = 0.04, r = -0.180).

The mean systolic blood pressure before and after hemodialysis were higher in men (131.40 mm Hg and 128.55 mm Hg) than in women (127.59 mm Hg and 126.40 mm Hg); however, these differences were not significant. The mean systolic blood pressure significantly decreased after hemodialysis (*P* = .01). There were no meaningful relationship between the mean systolic blood pressure and IOP changes after hemodialysis (*P* = .86).

The mean serum sodium levels were not significantly different after hemodialysis, as compared to values before dialysis in the women

Table 1. Demographic Data of Patients

Characteristic	Men	Women	All
Number of patients	38	27	65
Age			
< 70 years	26	15	41
≥ 70 years	12	12	24
Diabetes mellitus			
Yes	10	9	19
No	28	18	46
Hemodialysis sessions			
< 3 per week	3	11	14
≥ 3 per week	35	16	51

Table 2. Intraocular Pressure Its Correlation With Systemic Parameters Before and After Hemodialysis

Parameter	Before Hemodialysis	After Hemodialysis	*P*	Correlation*	
				r	*P*
IOP	13.50 ± 4.09	12.73 ± 4.07	.02	…	…
Blood glucose, mg/dL	147.34 ± 76.12	148.56 ± 43.71	.06	-0.180	.04
Systolic blood pressure, mm Hg	131.92 ± 18.87	128.07 ± 20.95	.01	0.150	.86
Serum sodium, mEq/L	138.75 ± 3.35	141.12 ± 2.57	< .001	-0.148	.48
Blood urea, mg/dL	163.83 ± 46.21	77.58 ± 25.54	< .001	0.168	.59
Serum potassium, mEq/L	5.19 ± 0.73	3.70 ± 0.43	< .001	0.127	.23
Body weight, kg	64.82 ± 13.88	62.00 ± 13.57	< .001	0.116	.40

*Correlation between changes in intraocular pressure and other parameters.

(138.44 mEq/L and 141.40 mEq/L) and in the men (138.97 mEq/L and 140.92 mEq/L). Neither was different the mean blood urea levels after hemodialysis in the women (160.22 mg/dL and 67.85 mg/dL) and in the men (166 mg/dL and 74.50 mg/dL). Although the overall differences in the mean serum sodium and blood urea levels before and after hemodialysis were significant ($P < .001$ for both), there were no significant relationships between serum sodium and blood urea levels and the IOP changes after hemodialysis ($P = .48$ and $P = .59$, respectively; Table 2). The mean serum potassium was significantly different after dialysis as compared to predialysis values (3.70 ± 0.43 mEq/L versus 5.19 ± 0.73 mEq/L, $P < .001$). However, there was no meaningful relationship between the mean serum potassium and IOP changes before and after hemodialysis ($P = .23$; Table 2).

Although the mean body weight of the patients significantly decreased after hemodialysis ($P < .001$), there was no significant relationship between the mean weight reductions and IOP changes before and after hemodialysis ($P = .40$; Table 2). The KT/V ranged between 1 and 1.2, and there were no significant relationship between KT/V and IOP changes after hemodialysis.

Duration of hemodialysis was 180 minutes in 57 patients and 240 minutes in 8 patients. There were no significant relationship between hemodialysis sessions duration and frequency and changes in the IOP. A history of retinopathy was present in 30 of the 130 eyes. There was not any history of glaucoma in any of the patients. There was no significant relationship between a history of retinopathy and changes in the IOP.

DISCUSSION

In normal condition, there exist a continuous secretion of aqueous humor inside the eyes, especially from nonpigmented epithelium of cilliary body, and its gradual drainage from anterior chamber angle structures of trabecular meshwork and Schlemm canal induces an acceptable intraocular pressure that is normally between 10 mm Hg and 21 mm Hg.[11,12] Increased IOP is a major risk factor for inducing glaucoma, and currently, reduction of IOP by means of medical or surgical approaches is the only treatment of choice for glaucoma.[13] Elevated IOP means that the IOP of the patient has exceeds the 97.5th percentile of the normal population.[14]

Despite lowering IOP by medical treatment, some glaucoma patients continue to experience disease progression and subsequent irreversible vision loss. Dysfunctional regulation of ocular blood flow in atherosclerosis, vasospasm and vascular endothelial dysfunction makes the diabetic or ESRD patients more susceptible to IOP changes. These conditions may contribute to decreases in ocular perfusion pressure, increase in IOP, and increased local metabolic demands and progression of glaucomatous optic neuropathy in these patients.[15]

Effects of hemodialysis on IOP have been a challenging issue in the medical literature and different hypothesis has been outlined in this topic.[10,16] Levy and colleagues described that although the effect of hemodialysis on IOP is unclear and even opposite findings may be encountered, in patients with glaucomatous eye, features of an acute rise in IOP are seen more frequently than normal individuals and future studies has been recommended.[17] In general, findings of this study revealed that there were meaningful inverse relationship between blood glucose level changes and IOP changes during hemodialysis. There were no significant relationship between changes in the IOP and serum sodium and potassium, blood pressure, blood urea, KT/V, weight, duration of hemodialysis, and underlying diseases before and after hemodialysis.

In the studies of Vrebac and colleagues and Dinc and coworkers carried out on 64 and 33 patients, IOP decreased by 1 mm Hg and 1.3 mm Hg, respectively, after hemodialysis, but no mechanistic effects have been described.[16,18] In the present study, the mean IOP decreased by 0.77 mm Hg after hemodialysis, and the proposed mechanisms have been described later.

Albertazzi and colleagues suggested that in their 20 patients, hemodialysis decreased serum osmolality and subsequently increased entry of water into the aqueous humor and vitreous, resulting in increased IOP.[19] Effects of osmolality on IOP have been proposed by some other studies. Leiba and colleagues concluded that the fluctuations in IOP were significantly correlated with the alteration in serum osmolality during hemodialysis.[20] Also Dujic and coworkers suggested that increased aqueous humor volume might be caused by the imbalance between blood and aqueous osmolality and the fluid shift into the ocular fluids in hemodialysis patients.[21] Some authors disagreed with this idea. Broekema and colleagues supposed that despite the drop in blood osmolality in hemodialysis patients, other regulatory forces prevent significant fluctuations in IOP.[22] In this experience, the mean IOP was significantly decreased in nondiabetics, possibly due to increase serum osmolality due to increased blood glucose levels.

Austin and colleagues reported that high-flux hemodialysis has no effects on IOP in patients undergoing intermittent hemodialysis.[23] Barbosa and associates found no significant differences in IOP and systolic blood pressure before, during, and after hemodialysis in 35 patients (67 eyes).[24] This is in contrast with the findings of the present study concerning IOP (in nondiabetics) and systolic blood pressure. In addition, Costagliola and Mastropasqua reported that no significant differences were observed in IOP, aqueous flow, outflow facility and resistance, corneal thickness, or lens diameter in patients receiving regular hemodialysis.[25] In the present study, both mean IOP (in nondiabetics) and systolic blood pressure were affected by hemodialysis. These differences may be due to the presence or absence of underlying disease such as diabetes mellitus, glaucomatous conditions, and changes in corneal thickness or crystalline lens diameter.

Underestimation of IOP values after hemodialysis sessions may happen due to decreased central corneal thickness induced by fluid loss.[16] Effects of fluid loss on corneal thickness may be a good explanation for IOP variations after hemodialysis, and reduced IOP in the first hour of hemodialysis happened in our patients may need stronger rationale. In eyes with an obstructed aqueous outflow pathway, an IOP elevation in response to decreased serum osmolality and intraocular fluid shift occurs in hemodialysis patients.[26] In this study, we excluded patients with any glaucomatous or with any angle problems to evaluate the actual role of fluid shift on IOP in normal ocular conditions. A decrease in IOP parallel to ultrafiltration-induced hemoconcentration has been reported, but exacerbation of glaucoma has only occasionally been observed. In ultrafiltration, intraocular compartments urea exceeds the blood urea and results in intraocular fluid influx, the mechanism that may be responsible for the increase in IOP in some hemodialysis patients.[27] In contrast, our study showed that ultrafiltration and urea rebound did not cause any incremental effects on IOP. In 36 hemodialysis patients, IOP changes had no significant correlation with plasma osmolality but correlated with the change in plasma colloid osmotic pressure and body weight.[28]

In this study we did not measure colloid osmotic pressure or blood osmolality, but blood urea, blood glucose, sodium, and potassium, which affect blood osmolality, were evaluated. The mean blood glucose levels increased after hemodialysis. Reduction in IOP levels after hemodialysis may be the effect of increase in serum osmolality. In the study of Gafter and colleagues on 30 patients, changes in body weight, blood pressure, and blood osmolality were significantly decreased with no significant changes in IOP.[29] Parallel with this, there were no meaningful relationship between changes in weight, systolic blood pressure, and IOP before and after hemodialysis in our study.

Dujic and coworkers found in a study on 29 patients that IOP increased after hemodialysis suggesting that all patients needed a concise ocular examination before hemodialysis.[21] In contrast, the mean IOP decreased in our patients after hemodialysis. This difference may be due to exclusion of patients with glaucomatous features in our study. In the study of Gutmann and Vaziri on 13 patients, mid-dialysis IOP was significantly lower than the postdialysis values, but the latter was not significantly different from the predialysis value. This stability in IOP may be due to improved dialytic technique.[30] Also, in Hojs and Pahor's study, there was no significant increase in IOP after hemodialysis that may be due to improved techniques related to hemodialysis.[31] In our study, IOP changes in different hours of hemodialysis indicated that the factors other than the duration of hemodialysis or electrolytes changes may influence IOP. Meanwhile, measuring of blood osmolality may help further understanding of pathophysiologic mechanisms involved in IOP changes in hemodialysis patients. Factors involved in IOP in hemodialysis patients are still not completely understood. In this study, we also found evidence of different hypotheses in the medical literature regarding changes in IOP during hemodialysis. It seems we need extended multicenter study with larger samples to determine the relationship between IOP and hemodialysis and their related factors.

CONCLUSIONS

Findings of this study revealed that increased mean blood glucose levels caused higher blood osmolality and outward fluid shift from within the eyes and the resultant decrease in IOP in hemodialysis patients without glaucomatous features. Indeed, there is an inverse relationship between blood glucose level changes and IOP changes in these patients. Also, changes in serum sodium, potassium, blood pressure, blood urea, KT/V, body weight, and hemodialysis frequency and duration had no effects on IOP after hemodialysis.

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CONFLICT OF INTEREST

None declared.

REFERENCES

1. Zadrazil J. [Aetiology and a clinical picture of chronic renal failure]. Vnitr Lek. 2011;57:607-13.
2. Ritz E, Zeng XX, Rychlik I. Clinical manifestation and natural history of diabetic nephropathy. Contrib Nephrol. 2011;170:19-27.
3. Cirillo M, Lombardi C, Mele AA, Marcarelli F, Bilancio G. A population-based approach for the definition of chronic kidney disease: the CKD Prognosis Consortium. J Nephrol. 2012;25:7-12.
4. Ciocalteu AM, Dumitrache M. [Effect of hemodialysis in retinal circulations]. Oftalmologia. 2011;55:103-8. Romanian.
5. Auyanet I, Rodriguez LJ, Bosch E et al. Measurement of foveal thickness by optical coherence tomography in adult haemodialysis patients with diabetic nephropathy. Nefrologia. 2011;31:66-9.
6. Hsiao CH, Chao A, Chu SY et al. Association of severity of conjunctival and corneal calcification with all-cause 1-year mortality in maintenance haemodialysis patients. Nephrol Dial Transplant. 2011;26:1016-23.
7. Nongpiur ME, Wong TY, Sabanayagam C, Lim SC, Tai ES, Aung T. Chronic kidney disease and intraocular pressure: the Singapore Malay Eye Study. Ophthalmology. 2010;117:477-83.
8. Rever B, Fox L, Christensen R, Bar-Khayim Y, Nissenson AR. Adverse ocular effects of acetate hemodialysis. Am J Nephrol. 1983;3:199-204.
9. Pakdel F, Samimagham H, Shafaroodi A, Sheikhvatan M. Changes of serum calcium, phosphorus, and parathyroid hormone concentrations and ocular findings among patients undergoing hemodialysis. Saudi J Kidney Dis Transpl. 2011;22:1142-8.
10. Samsudin A, Mimiwati Z, Soong T, Fauzi MS, Zabri K. Effect of haemodialysis on intraocular pressure. Eye (Lond). 2010;24:70-3.
11. Hitchings RA. The Duke Elder Lecture. Flying blind. Eye (Lond). 1997;11:771-8.
12. Mitchell P, Smith W, Attebo K, Healey PR. Prevalence of open-angle glaucoma in Australia. The Blue Mountains Eye Study. Ophthalmology 1996;103:1661-9.
13. Malihi M, Sit AJ. Aqueous humor dynamics and implications for clinical practice. Int Ophthalmol Clin. 2011;51:119-39.
14. Casson RJ, Chidlow G, Wood JP, Crowston JG, Goldberg I. Definition of glaucoma: clinical and experimental concepts. Clin Experiment Ophthalmol. 2012;40:341-9.
15. Moore D, Harris A, Wudunn D, Kheradiya N, Siesky B. Dysfunctional regulation of ocular blood flow: A risk factor for glaucoma? Clin Ophthalmol. 2008;2:849-61.
16. Dinc UA, Ozdek S, Aktas Z, Guz G, Onol M. Changes in intraocular pressure, and corneal and retinal nerve fiber layer thickness during hemodialysis. Int Ophthalmol. 2010;30:337-40.
17. Levy J, Tovbin D, Lifshitz T, Zlotnik M, Tessler Z. Intraocular pressure during haemodialysis: a review. Eye (Lond). 2005;19:1249-56.
18. Vrabec R, Vatavuk Z, Pavlovic D, et al. Ocular findings in patients with chronic renal failure undergoing haemodialysis. Coll Antropol. 2005;29:95-8.
19. Albertazzi A, Di PB, Spisni C, Mastropasqua L, Gallenga PE. Intraocular pressure (IOP) changes induced by regular dialysis treatment (RDT). Life Support Syst. 1985;3:91-5.
20. Leiba H, Oliver M, Shimshoni M, Bar-Khayim Y. Intraocular pressure fluctuations during regular hemodialysis and ultrafiltration. Acta Ophthalmol (Copenh). 1990;68:320-2.
21. Dujic M, Markovic P, Jovanovic D, Dragicevic P, Radovanovic L. [Changes in intraocular pressure during dialysis]. Srp Arh Celok Lek. 1997;125:257-60.
22. Broekema N, van Bijsterveld OP, de Bos Kuil RJ. Intraocular pressure during hemodialysis. Ophthalmologica. 1988;197:60-4.
23. Austin JN, Klein M, Mishell J, et al. Intraocular pressures during high-flux hemodialysis. Ren Fail. 1990;12:109-12.
24. Barbosa CP, Stefanini FR, Penha F, et al. Intraocular pressure and ocular perfusion during hemodialysis. Arq Bras Oftalmol. 2011;74:106-9.
25. Costagliola C, Mastropasqua L. The influence of hemodialysis on intraocular pressure: III. Aqueous humor dynamics and tissue hydration. Ann Ophthalmol. 1991;23:31-4.
26. Tawara A. [Intraocular pressure during hemodialysis]. J UOEH. 2000;22:33-43. Japanese.
27. Tovbin D, Belfair N, Shapira S et al. High postdialysis urea rebound can predict intradialytic increase in intraocular

pressure in dialysis patients with lowered intradialytic hemoconcentration. Nephron. 2002;90:181-7.

28. Tokuyama T, Ikeda T, Sato K. Effect of plasma colloid osmotic pressure on intraocular pressure during haemodialysis. Br J Ophthalmol. 1998;82:751-3.
29. Gafter U, Pinkas M, Hirsch J, Levi J, Savir H. Intraocular pressure in uremic patients on chronic hemodialysis. Nephron. 1985;40:74-5.
30. Gutmann SM, Vaziri ND. Effect of hemodialysis on intraocular pressure. Artif Organs. 1984;8:62-5.
31. Hojs R, Pahor D. Intraocular pressure in chronic renal failure patients treated with maintenance hemodialysis. Ophthalmologica. 1997;211:325-6.

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