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Research Article

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Ophthalmological Complications in Dialysis Patients: A Study of 50 Cases

Benhadda Selim*, Guennoun Aziza, Saidi Imane, Benamar Loubna, Ouzeddoun Naima and Bouattar Tarik

Department of Nephrology Dialysis, IBN SINA Hospital, Rabat, Morocco

***Corresponding Author**
Benhadda Selim, Department of Nephrology Dialysis, IBN SINA Hospital, Rabat, Morocco

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1. Introduction

Several ocular anomalies can be found in dialysis patients, both due to uremic conditions and specific complications of dialysis [1]. These anomalies include changes in refraction, abnormalities of the ocular surface, conjunctival calcium deposits, ischemic optic neuropathy, decreased corneal endothelial cell density, and variations in intraocular pressure (IOP) [1]. Clinicians face a range of symptoms, from simple irritation to ocular pain and vision loss, highlighting the need of an ophthalmic examination in this patient population to detect and prevent complications that may impact visual prognosis [1]. Only few studies in the literature describe these lesions in patients undergoing peritoneal dialysis. The aim of our study is to determine the prevalence of ophthalmic conditions in dialysis patients, describe the various lesions found in our patients, and identify potential risk factors for the most common complications.

2. Material and Methods

This was a cross-sectional study conducted at Ibn Sina Hospital in Rabat, including 50 patients (25 chronic hemodialysis patients and 25 peritoneal dialysis patients). The study involved a total of 100 eyes, and the following data were recorded: age, gender, initial nephropathy, duration on dialysis, and the number of hemodialysis sessions per week.

For hemodialysis patients, blood pressure, urea, creatinine, and blood glucose levels were recorded before and after hemodialysis, along with KT/V and URR as markers of dialysis adequacy. For peritoneal dialysis patients, KT/V, nPCR, and weekly clearance were recorded as markers of dialysis adequacy.

An ophthalmic examination was conducted for all patients, including measurement of visual acuity for distance and near vision, with and without correction, an examination of the appendages, the anterior segment and the posterior segment. Dry eye evaluation was performed using two tests, the Break Up Time (BUT) and the Schirmer test. Intraocular pressure was measured using a Goldmann applanation tonometer before and after hemodialysis. This measurement was performed once for peritoneal dialysis patients.

Statistical analysis was carried out using SPSS 13.0 software. Quantitative variables were expressed as means and standard deviations, while qualitative variables were expressed as frequencies and percentages.

3. Results

Fifty patients were included in this study, with a mean age of 48.74 ± 14.46 years, ranging from 17 to 74 years, and a male-to-female ratio of 0.9. The initial nephropathy was undetermined in 42% of cases, with 12% of patients having diabetic nephropathy and 16% having nephrosclerosis.

All patients had ophthalmic involvement, all lesions combined. Patients were divided into two groups: chronic hemodialysis patients and peritoneal dialysis patients. The mean age for hemodialysis patients was 49.84 ± 10.9, with an average dialysis duration of 456.2 ± 130.8 months. For peritoneal dialysis patients, the mean age was 47.64 ± 17.47, with an average dialysis duration of 34.8 ± 25.2 months. The mean age was similar between the two groups ($p > 0.5$), while the average dialysis duration showed a significant difference ($p = 0.01$). 86% of our patients had good dialysis adequacy.

Clinical symptoms included decreased visual acuity in 46% of patients. Ocular redness, tearing, itching, and ocular pain reported respectively in 32%, 30%, 28%, and 18% of cases, respectively. Among the 100 eyes examined, decreased visual acuity was found in 54% of cases. Corrected distance visual acuity was less than 5/10 in 48% of cases. 44% of patients were emmetropic and had normal refraction.

Examination of adnexal structures revealed conjunctival hyperemia in 38 cases (76%), conjunctival calcifications in 21 cases (42%), and dry eyes in 23 cases (46%).

Pterygium was observed in 14% of cases, and pterygoid limbal nodules in 6% of cases. No patients exhibited corneal calcifications or band keratopathy. Cataracts were found in 78% of cases, primarily cortical-nuclear cataracts in 58% of cases. Posterior segment examination revealed fibrillar vitreous in

15.7% of patients. Eye fundus showed pathological excavation of the papilla in 14% of patients. No patients had macular edema or age-related macular degeneration (AMD). Retinal examination revealed stage 1 hypertensive retinopathy in 4 patients and stage 4 hypertensive retinopathy in 2 patients. No retinal detachment was noted.

In our study, we demonstrated that the frequency of calcifications was associated with parathyroid hormone (PTH) levels ($p < 0.01$), dialysis duration ($p < 0.01$), and alkaline phosphatase (ALP) levels ($p = 0.01$). However, no relationship was noted with age ($p = 0.3$), calcium levels ($p = 0.2$), and phosphorus levels ($p = 0.5$). Peritoneal dialysis seemed to reduce the risk of conjunctival calcifications compared to hemodialysis ($p < 0.01$), likely due to the shorter duration of peritoneal dialysis in our patients compared to hemodialysis ($p < 0.01$). Hypertensive patients had fewer calcifications compared to normotensive patients ($p < 0.01$).
Hyperemia or redness was not associated with phosphocalcium metabolic abnormalities or other risk factors.

For hemodialysis patients, the Break Up Time (BUT) test was positive in 60% of cases, indicating poor tear film quality, while the Schirmer test was positive in 52% of cases, indicating quantitative abnormalities in the tear film. 8% of patients had isolated qualitative tear film abnormalities. No discordance between the two tests was observed for peritoneal dialysis patients. No predisposing factors for dry eyes were found in our study.

We observed that 30 patients developed cataracts in our study, despite the non-significant difference between these two groups in terms of age and cardiovascular risk factors. These factors are typical predisposing factors for this type of lesion.

In hemodialysis patients, the intraocular pressure (IOP) taken before hemodialysis was approximately (15.68 ± 2.11) mmHg. After hemodialysis, the IOP was approximately (12.36 ± 1) mmHg, showing a non-significant decrease in pressure of approximately 3.3 ± 1.1 mmHg. The IOP in peritoneal dialysis patients, measured once, was (16.4 ± 2.3) mmHg. None of our patients exhibited intraocular hypertension.

In our study, the mean variation in body weight after hemodialysis was -2.7 ± 1.1 kg. The average serum osmolarity at the beginning and end of hemodialysis sessions was 266 ± 9.5 mOsm/L and 323 ± 17.4 mOsm/L, respectively, with an average increase of $+57 \pm 7.9$ mOsm/L ($p < 0.01$). The mean variation in mean blood pressure was -3.8 ± 6.5 mmHg (p 0.1). There was a significant change between urea concentration and serum osmolarity before and after hemodialysis.

4. Discussion

Ocular lesions are common in dialysis patients, with ocular involvement observed in 100% of patients in our study. Regardless of traditional risk factors such as age, diabetes, and hypertension, chronic kidney disease (CKD) can induce ocular disorders resulting from metabolic changes and hemodialysis treatment [3]. Early screening of these lesions is crucial for management before the onset of complications.

An elevation in serum calcium or phosphate concentration beyond the in vivo solubility capacity in the eye can lead to the deposition of calcium phosphate salts in the form of microcrystalline hydroxyapatite. These deposits are associated with an inflammatory reaction causing painful and irritated red eyes [4, 5]. Simultaneously, the association between irritable red eyes and renal insufficiency has been studied in various works, primarily due to nonspecific inflammation occurring in the conjunctiva [2].

In our study, conjunctival hyperemia or redness was observed in 38 patients, without significant phosphocalcic abnormalities compared to patients without conjunctival hyperemia. Abram Al was the first to identify the association between red eyes and chronic kidney disease, The examination of the anterior segment revealed a red eye with conjunctival calcifications in 81.3% of cases, localized on both the temporal and nasal sides of the limbus [6].

Berlyne and Shaw suggested a possible association between red eyes and serum phosphate concentration rather than calcium concentration [7]. Another study reported that diffuse hyperemia is more closely related to higher serum calcium levels compared to phosphate levels [8].

The treatment should focus on controlling the levels of calcium, and phosphate (ideally <55mg/l). Symptomatic treatment may sometimes be associated, including antihistamines, vasoconstrictors, or lubricants [9].

In our study, the analysis of various anomalies reveals that the frequency of calcifications is linked to the levels of parathyroid hormone (PTH) ($p < 0.01$), the duration of dialysis ($p < 0.01$), and alkaline phosphatase levels ($p = 0.01$). However, no significant correlation was noted with age ($p = 0.3$), calcium levels ($p = 0.2$), and phosphorus levels ($p = 0.5$).
Peritoneal dialysis appears to reduce the risk of conjunctival calcifications compared to hemodialysis ($p < 0.01$). This is likely due to the shorter duration of peritoneal dialysis in our patients compared to hemodialysis ($p = 0.01$).

Several studies have attempted to demonstrate the association between corneo-conjunctival calcifications (CCC) and mortality in dialysis patients. In a Taiwanese study, the grading of aortic arch calcification is significantly associated with moderate and severe CCC. Severe CCC is a predictor of mortality in hemodialysis patients, after adjusting for other significant factors. This finding suggests the need to monitor CCC in hemodialysis patients [10].

Most patients with advanced chronic kidney disease have other comorbidities independently associated with an increased risk of cataracts. These include advanced age, diabetes, hypertension, the use of corticosteroids, and hyperparathyroidism [11]. A specific mechanism for cataract formation in patients with CKD has been proposed. It is considered as an osmotic cataract,

resulting from variations in blood urea levels before and after dialysis, and oxidative stress [2].

In our study, cataracts can occur independently of risk factors. The tear film is a complex and delicately balanced entity [12]. Several etiologies can alter the composition of this film despite local causes, including systemic conditions, hormonal and metabolic disorders, and toxic conditions such as uremia [3].

Long-term hemodialysis can lead to changes in the tear film and ocular surface. An increase in urea concentration in tears and a decrease in tear production after hemodialysis result in an elevated tear osmolarity [13].

The Schirmer test assesses the quantity of the tear film, while the BUT (Break Up Time) test evaluates its quality. Ozdemir, et al. investigated the relationship between ocular surface disorders and lacrimal function in CKD patients. They found that abnormal BUT test results were significantly more common in the dialysis group than in the control group. However, the results of the Schirmer test were similar between patients and control groups. The diagnosis of dry eye was established by the BUT and Schirmer tests in 68.8% and 37.1% of cases, respectively. This study also demonstrated that there was no significant difference between Schirmer test results between the patients group and the control group ($p = 0.20$) [14].

Ocular irritation symptoms in hemodialysis patients may not be related to aqueous insufficiency. The primary mechanism could be inflammation and instability of the tear film due to an inflammatory process [14].

Intraocular pressure (IOP) is measured by various techniques. Currently, Goldmann applanation tonometry is considered the gold standard in assessing IOP [1]. The effect of hemodialysis on IOP has been a controversial topic in the literature since its initial evaluation in the 1960s. Various theories regarding this relationship have been proposed [2]. Study results are inconclusive, which may be attributed to methodological differences, such as varying exclusion criteria, variable sample sizes, and different tonometry techniques, and possibly due to significant technical advancements in the hemodialysis procedure itself over the years [15].

Studies describe either an increase or a decrease in intraocular pressure (IOP) during hemodialysis or no change at all [2]. The decrease in IOP can be attributed to various mechanisms, particularly dehydration resulting from excessive fluid loss after hemodialysis. Dehydration is associated with an increase in plasma osmotic pressure during dialysis [16].

The plasma is separated from the aqueous humor by the blood-aqueous barrier and from the dialysate by the dialysis membrane. The plasma volume decreases due to the removal of water from the plasma with a relative increase in plasma protein concentration. This results in an increase in osmotic pressure. Consequently, water is pushed from the aqueous humor into the plasma, causing a decrease in IOP [16].

Tokuyama, et al. studied a total of 36 hemodialysis patients aged between 30 and 81 years with no apparent ocular disease. Their seated IOP was evaluated using Goldmann applanation tonometry. The IOP decreased during hemodialysis (-1.8 mmHg), while plasma osmotic pressure increased (3.8 mmHg) [17].

In a prospective controlled study by Dinc, et al, the authors concluded that IOP can decrease to some extent after hemodialysis (average reduction of 1.3 ± 2.4 mmHg) [18]. No significant correlation was established between total fluid loss, serum osmolality, and changes in IOP.

Doshiro, et al.'s study is currently the one that has included the largest number of elderly patients. The authors examined 188 eyes of 95 patients, 105 men and 83 women. The results of this study demonstrate a significant decrease in IOP during hemodialysis. Body weight, systolic and diastolic blood pressure also decreased significantly.

However, plasma osmotic pressure increased significantly. This finding is consistent with the previous results of Tokuyama, et al [19]. Afshar, et al concluded that an increase in blood glucose can induce a reduction in IOP in hemodialysis-treated patients without glaucomatous characteristics due to an increase in serum osmolality [20].

A recent study evaluated changes in choroidal thickness inside and outside the macula after a hemodialysis session (HD) in patients with end-stage renal failure. It was demonstrated that changes in body weight, serum osmolality, and blood pressure during dialysis could affect choroidal thickness inside and outside the macula [21]. Prospective studies are needed to assess the impact of this IOP variation on the eyes of dialysis patients.

It is imperative to ensure reliable ophthalmological follow-up and management in individuals treated with hemodialysis who may experience an increase in IOP or in patients with glaucoma or ocular hypertension. These individuals are at risk of an acute angle-closure glaucoma crisis. Appropriate topical medications that reduce IOP should be considered for these patients. These agents decrease the production of aqueous humor (beta-blockers, carbonic anhydrase inhibitors, etc.) or increase.

An elevation in IOP during hemodialysis can be painful. A case is described in the literature of recurrent and painful spikes in IOP during the session in a patient with unilateral anterior uveitis not responding to conventional medical treatment before hemodialysis [22].

The nephrologist should be aware of the possibility of a painful elevation of IOP during hemodialysis in patients with compromised uveitis.

Various intradialytic manipulations can affect IOP. This includes longer session duration or the use of daily dialysis to reduce the development of a significant osmotic gradient between the blood and the eyeball [11].

Recent studies suggest that, with improved hemodialysis techniques and better uremia control, a significant elevation in IOP is less likely in individuals without signs of ocular pathology. Peritoneal dialysis is beneficial in preventing a significant increase in IOP in sensitive individuals susceptible to vision loss [23].

Clinical signs	n	%
Functional symptoms :		
Decreased visual acuity	23	46
Redness	16	32
Tearing	15	30
Itching	14	28
Pain	9	18
Physical signs		
Cataracte	39	78
Conjonctival Hyperemia	38	76
Blurred vision	27	54
Dry eyes	23	46
Conjonctival calcifications	21	42
Pterygium	7	14
Pathological papillary excavation	7	14
Hypertensive retinopathy	7	14
Pterygoid	6	12
	3	6

Table 1: Various Ophthalmological Conditions in Dialyzed Patients

Risk factors	Presence of calcification n=21 (42%)	Absence of calcification n=29 (58%)	OR	IC	P
Average age (Years)	51 +/-12,1	47,1 +/-15,9	0.9	0.883-1.034	0.3
Dialysis duration (years)	16,5 +/8,5	5.2 +/- 5.1	1.008	1.134-2.935	<0.01
Diabetes	1(4%)	1(3%)	1,063	0,950-1.189	0,7
Hypertension	4(19%)	20(68%)	1,003	1,932-2.080	0,01
Calcium (mg/l)	89,3+/-8,8	86,4+/-8,7	1,063	0,950-1,189	0.2
Phosphorus (mg/l)	45,8+/-14,07	43,5+/-12,7	1.003	0.932-1.080	0.5
ALP (UI/l)	359,6 +/577,8	219,1+/-146,10	0.992	0.983-1.001	0.01
PTH (pg/ml)	713,3+/-693,9	216,6+/-100,8	1.002	1.000-1.004	<0.01
Hemodialysis	19(90%)	6(20%)	1.995	1,183-2.034	<0.01
Peritoneal dialysis	2(9%)	23(79%)	1,828	1,734-1.955	<0.01

Table 2: Risk Factors for Calcifications in Dialyzed Patients

	Patients with hyperemia (n=38)	Patients without hyperemia (n=12)	OR	IC	P
Average age (Years)	48.5+/-15.1	49.5+/-12.5	1.016	0.960-1.074	0.8
Dialysis duration (years)	11+/-8.8	13.1+/-10.9	1.061	0.972-1.158	0.5
Diabetes	2(5%)	0	0.995	0,883-1.034	0,3
Hypertension	21(55%)	3(25%)	0,828	0,734-0.955	0,02
Calcium (mg/l)	87+/-9	88.5+/-13.2	1.017	0.929-1.113	0.8
Phosphorus (mg/l)	43.9+/-13	46.1+/-13.1	1.030	0.961-1.103	0.3

ALP (UI/l)	314+/-448	215+/-143	0.998	0.995-1.002	0.4
PTH (pg/ml)	691+/-751	375.3+/-363.8	0.999	0.997-1.001	0.2
Hemodialysis	18(47%)	7(58.3%)	0.995	0,883-1.034	0.5
Peritoneal dialysis	20(52%)	5(41.6%)	0,828	0,734-0.955	0,5

Table 3: Risk Factors for Conjunctival Hyperemia in Dialyzed Patients

	Patients with dryness (n=23)	**Patients without dryness (n=27)**	**OR**	**IC**	**P**
Average age (Years)	50.4+/-12.8	47.3+/-15.8	0.995	0,883-1.034	0.4
Dialysis duration (years)	14.1+/-9.1	9.3+/-9	1,828	2,734-3.955	0.01
Diabetes	2(8%)	0	1,063	0,950-1,189	0,05
Hypertension	10(43%)	14(51%)	1.003	0.932-1.080	0,7
Calcium (mg/l)	88.5+/-9.7	87.7+/-8.2	1,063	0,950-1.189	0.7
Phosphorus (mg/l)	43.2+/-11.2	46.2+/-15.1	1,003	0,932-1.080	0.4
ALP (UI/l)	182.9+/-90	380.6+/-518.2	0,992	0,983-1.001	0.08
PTH (pg/ml)	623.6+/-737.4	608.9+/-671	1,002	1,000-1.004	0.9
Hemodialysis	15(65%)	10(37%)	0.998	0.995-1.002	0.4
Peritoneal dialysis	8(34%)	17(62%)	0.999	0.997-1.001	0,4

Table 4: Factors Favoring Dry Eyes in Dialyzed Patients

	Patients with cataract n=30	**Patients without cataract n=20**	**OR**	**IC**	**P**
Average age (Years)	48.9+/-13.1	48.1+/-19.1	0,989	0,937-1.045	0.8
Dialysis duration (years)	11.2+/-9.3	12.6+/-9.6	1,023	0.933-1.121	0.7
Diabetes	2(6%)	0	0.995	0,883-1.034	0.3
Hypertension	18(60%)	10(50%)	0,828	0,734-0.955	0,9
Calcium (mg/l)	88+/-9.1	88.5+/-8.6	0,999	0,912-1.094	0.8
Phosphorus (mg/l)	43.5+/-13.8	49.5+/-11.3	1,036	0,975-1.100	0.2
ALP (UI/l)	251.1+/-20.9	436.1+/-779.5	1,000	0,999-1.002	0.1
PTH (pg/ml)	347.1+/-651.2	836.2+/-814.8	1,000	0,999-1.002	0.2
Hemodialysis	20(66%)	10(50%)	1.017	0.929-1.113	0.2
Peritoneal dialysis	10(33%)	10(50%)	1.030	0.961-1.103	0,2

Table 5: Risk Factors for Cataract in Dialyzed Patients

Parameters	**Before Hemodialysis**	**After Hemodialysis**	**(P)**
IOP(mmHg)	15,68+/-2,11	12,36+/-1.	0.2
Glycemia(g/l)	2.1+/-0.5	1,98+/-0,7	0.5
Blood pressure(mmHg)	131,92+/-18,7	128,07+/-20,2	0.1
Na+(Meq/l)	138,7+/-3,4	128,07+/-9,9	0.3
Urea(g/l)	2,1+/-0,7	0.8+/-0,5	<0.01
K+(Meq/l)	5,19+/-0,73	3,7+/-0,43	0.1
Body weight (kg)	64,82+/13,7	62,01+/-14,01	0.2
Serum osmolality (mosm/l)	266+/9,5	323+/17,4	<0.01

Table 6: Effect of Hemodialysis on Hemodynamic and Biological Parameters

5. Conclusion

Dialyzed patients are prone to various ophthalmological complications. These individuals should undergo routine focused ophthalmological examinations to detect and treat these lesions. In our study, we were able to identify predisposing risk factors for conjunctival calcifications, such as age, duration of dialysis, and secondary hyperparathyroidism.

Neither of the two purification techniques appears to expose patients to more ocular impairments than the other; however, peritoneal dialysis contributes to better control of elevated intraocular pressure (IOP) in predisposed patients.

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