Major Ocular Abnormalities Among Hemodialysis Patients in Indonesia

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ABSTRACT

Background: *This study aimed to identify the major ocular abnormality findings (i.e., cataract and conjunctival and corneal calcification (CCC)) among hemodialysis (HD) patients and their risk factors.* ***Methods:*** *A single institute-based cross-sectional study in Indonesia. Demographic data, medical histories, and complete ocular examinations were collected. For two major ocular abnormalities found, a generalized estimating equation was incorporated in a logistic regression model to assess the relationship with their risk factors.* ***Results:*** *We analyzed 318 eyes (159 individuals), of which 54.7% male and 45.3% female. The mean age was 51.6±11.3 years. The mean HD period was 3.5±3.2 years. Hypertension and diabetes mellitus (DM) was found in 81.1% and 34.6%, respectively. The major ocular abnormalities found were cataract (206 eyes; 64.78% (95% CI 59.53-70.03)), followed by CCC (135 eyes; 42.45% (95 % CI 37.02-47.88)). In a multivariate model, higher education (odds ratio (OR) 0.17; 95% CI 0.04-0.74), hypertension (OR 0.15; 95% CI 0.03-0.79), DM (OR 10.49; 95% CI 1.57-70.06), Systolic Blood Pressure (SBP) 120-129 mmHg (OR 0.05; 95% CI 0.003-0.69), SBP ≥140 mmHg (OR 0.05; 95% CI 0.004-0.67), Diastolic Blood Pressure (DBP) 80-89 mmHg (OR 7.44; 95% CI 1.13-48.73), and DBP ≥90 mmHg (OR 48.47; 95% CI 3.4-692.03) showed significant association with cataract. Meanwhile, there was no significant association between CCC and any predictor.* ***Conclusion:*** *Cataract and CCC were found to be the major ocular abnormalities among HD patients in this study, with DM and higher DBP as the risk factors for cataract. This finding supports recommendations for integrated regular eye screening in HD patients.*

Keywords**:** *hemodialysis, ocular abnormality, ocular manifestation, chronic kidney disease, health-system*

INTRODUCTION

It has been estimated that 2.16 million people in Asia will need renal replacement therapy (RRT) by 2030.[1] This increasing trend of the prevalence and incidence of end-stage renal disease (ESRD) in patients was seen in

a study in Indonesia a few years ago.[2] Several studies have demonstrated ocular manifestations among patients with chronic kidney disease (CKD),[3–5] and ESRD undergoing hemodialysis (HD).[6–9] The increased frequency of ocular abnormality in the HD population may perhaps be explained by genetic factors, socioeconomic disparities, difficult access to treatment, and poor diabetes and hypertension management in some individuals.[10]

Some of the most common ocular abnormalities found in CKD or HD patients include corneal and conjunctival calcification (CCC),[11] that are strongly associated with vascular calcification,[12] cataract,[3,7,11] and diabetic retinopathy, and are possibly reversible in their most curable stage if diagnosed early.[13,14] Rim et al. also showed that patients who began HD were more likely to undergo cataract surgery,[15] however the Beijing eye study demonstrated that CKD was not significantly associated with any major ocular diseases.[16] Due to the tremendous implications of any visual impairment,[6,17] morbidity,[7] or social capacity of dialytic patients, an interdisciplinary approach and eye screening are necessary to prevent further complication.[3,6,7] Since the patients may not complain of any visual problem until the vision is lost,[14] the dialysis community also needs to be aware of the high incidence rate of visual loss.[18]

In Indonesia, limited studies and data are provided related to the pattern of ocular abnormalities in HD patients, which is a vulnerable subject with high-risk ocular pathology and proves a barrier in getting access to the ophthalmology unit. This study aims to identify the major ocular abnormalities found among regular HD patients and find their risk factors. Furthermore, to highlight the importance of having a standard protocol and an integrated periodic ocular screening among HD patients, we hypothesized that the prevalence of ocular abnormalities would be relatively high and that some ocular abnormalities would be associated with certain risk factors.

METHODS

This cross-sectional study was conducted at Hemodialysis (HD) Unit, Dr. Soetomo General Academic Hospital (DSGAH), Surabaya, Indonesia, in May-June 2019. This study was supported by the Universitas Airlangga Research Grant. An ethical clearance approval was obtained from the institutional review board of DSGAH (*Komisi Etik Peneliti Kesehatan Rumah Sakit Dr. Soetomo* No.1155/KEPK/V/2019). All subjects underwent regular HD, twice per week at the HD unit. Before subject recruitment, written informed consent was obtained from all the participants. All the procedures performed in this study were in accordance with the ethical standards of the institutional research committee and the Declaration of Helsinki.

The inclusion criteria consisted of all patients who underwent regular HD in HD unit, DSGAH, and were willing to join the research, while the exclusion criteria included physical weakness during the examination, history of malignancy, and underwent renal transplantation during the study. Demographic profiles and medical histories including age, gender, education, occupation, HD period (years), etiology (hypertension, diabetes mellitus), body mass index (BMI), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were collected. Body weight, SBP, and DBP were measured before the HD session started. The complete ocular examination started with the best-corrected visual acuity (BCVA) examination by logarithmic (LogMAR) visual acuity chart, ETDRS, and was followed by intraocular pressure (IOP) measurement. The biomicroscopic examination was performed using slit-lamp biomicroscopy and fundus examination by well-trained ophthalmologists.

Study Variables

As for lens-related findings, we classified them into normal lens, immature cataract, mature cataract, and post cataract surgery. Immature cataract was defined as lens opacity associated with a mild to moderate degree of visual impairment, while mature cataract was defined as lens opacity associated with severe to blindness degree of visual impairment. Post cataract surgery findings, classified into pseudophakic and aphakic, were considered as cataract in the analysis. Conjunctival and corneal calcification (CCC) was graded according to the method described by Porter and Crombie in 1973.[19]

Age, sex, education, occupation, HD period, hypertension, diabetes mellitus, BMI, SBP, and DBP were considered as predictors. Age was classified into 4 groups (less than 40, 40-49, 50-59, and ≥60) and sex was classified into female and male. Education was classified as ≤9 years and >9 years of basic compulsory education, whereas occupation was classified as unemployed/retired or employed. HD period was classified into 4 groups (<1, 1-5, 6-10, >10 years), based on average life expectancy and the survival rate on dialysis.[20–22] Dichotomous variables were employed for hypertension and diabetes mellitus according to the history taken from patients' medical records. Body mass index (BMI) was classified into 4 groups based on WHO's classification (underweight, normal, overweight, and obese).[23] Systolic blood pressure (normal, elevated, grade 1, grade 2) and diastolic blood pressure (normal elevated, grade 1, grade 2) were classified according to American College of Cardiology/ American Heart Association Clinical Practice Guidelines, 2017.[24]

Statistical Analysis

For statistical analysis, both eyes of each patient were taken into account. Stata version 15 (StataCorp, College Station, TX, USA) was used to perform all the statistical analyses, p values <0.05 were considered statistically significant. The results were reported as a percentage for categorical variables and as mean and standard deviation (SD) with a range for the quantitative variables. For the purpose of analysis, a binary variable was employed for cataract and CCC. Pseudophakic eyes and aphakic eyes were considered as cataracts, while grading for CCC was simplified to grade 0 indicating no calcium deposits and grade 1 indicating calcium deposits found in conjunctiva only or both conjunctiva and cornea.

A generalized estimating equation model was incorporated in the logistic regression models to assess the relationship between ocular abnormalities (cataract and CCC) and their risk factors in HD patients, adjusting for the inter-eye correlation. Crude and adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated to investigate the association between the abnormalities of and predictors for each eye.

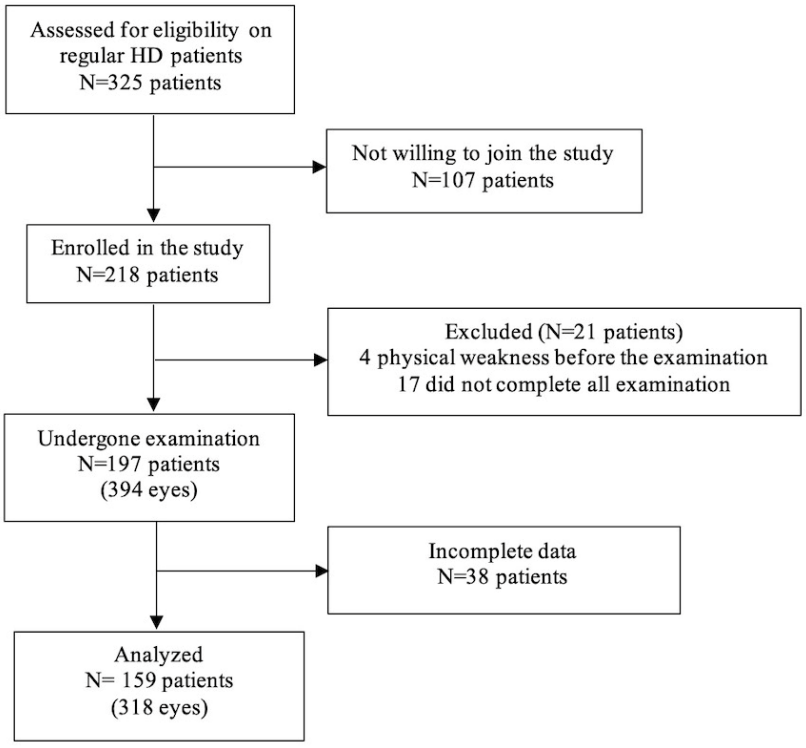

Figure 1. Flowchart of enrolment of HD patients.

RESULTS

This study registered 218 individuals. Eye examinations were performed for 197 patients (394 eyes), but 38 individuals were excluded from the analysis due to missing variables (**Figure 1**). Of 159 patients, 87 (54.7%) were male and 72 (45.3%) were female. The mean age was 51.6±11.3 (range: 21-82) years, with the most prevalent age group being 50-59 years (57 subjects; 35.9%). We found 53 (33.4%) subjects underwent ≤9 years basic compulsory education in Indonesia and the rest (66.6%) had achieved >9 years basic education. Most of the patients were unemployed or retired (89; 56%) (**Table 1**).

Table 1. Demographic Characteristics of Hemodialysis Patients (N=159)

Characteristic	Value
Age (years)	
Mean±SD	51.6 ± 11.3
Median (Range)	52 (21-82)
Age Category (years), n (%)	
<40	26 (16.3)
40-49	40 (25.2)
50-59	57 (35.9)
≥60	36 (22.6)
Sex (n,%)	
Male	87 (54.7)
Female	72 (45.3)
Basic Compulsory Education (n,%)	
≤9 years	53 (33.4)
>9 years	106 (66.6)
Occupation (n,%)	
Unemployed/retired	89 (56.0)
Employed/work	70 (44.0)

Tablel 2. Systemic Characteristic of Hemodialysis Patients (N=159)

Characteristic	Value
HD Period (years)	
Mean±SD	3.5 ± 3.2
Median (Range)	2.5 (0.08-14)
HD Period Category (n,%)	
<1 year	52 (32.7)
1-5 years	73 (45.9)
6-10 years	26 (16.4)
>10 years	8 (5.0)
Hypertension Etiology (n,%)	
Yes	129 (81.1)
No	30 (18.9)
Diabetes Mellitus Etiology (n,%)	
Yes	55 (34.6)
No	104 (65.4)
Body Mass Index (BMI)	
Mean±SD	23.1±4.2
Median (Range)	22.5 (13.9-40.8)
BMI Category (n,%)	
Underweight <18.5	17 (10.7)
Normal 18.5-22.9	72 (45.3)
Overweight 23-24.9	31 (19.5)
Obese ≥25	39 (24.5)
Systolic Blood Pressure (mmHg)	
Mean±SD	144.3±22.2
Median (Range)	140 (95-210)
Systolic Blood Pressure Category (n,%)	
Normal (<120)	17 (10.7)
Elevated (120-129)	16 (10.1)
Grade 1(130-139)	19 (11.9)
Grade 2 (≥140)	107 (67.3)
Diastolic Blood Pressure (mmHg)	
Mean±SD	82±10.5
Median (Range)	80 (45-121)
Diastolic Blood Pressure Category (n,%)	
Normal-Elevated (<80)	32 (20.1)
Grade 1 (80-89)	62 (39.0)
Grade 2 (≥90)	65 (40.9)

From the systemic characteristics of the patients, the mean HD period was found to be 3.5±3.2 (range: 0.08-14) years. As many as 73 (45.9%) patients underwent HD for 1-5 years (**Table 2**). Hypertension was found in 129 cases (81.1% (95% CI 75.05-87.21)), while DM was found in 55 cases (34.6% (95% CI 37.19-41.98)). The mean BMI was 23.1±4.2, with the most prevalent BMI (72; 45.3%) considered normal BMI. The mean SBP was 144.3±22.2 (95-210) mmHg and the mean DBP was 82±10.5 (45-121) mmHg. Most of the patients were found with SBP grade 2 (107; 67.3%) and DBP grade 2 (65; 40.9%) (**Table 2**). The two major ocular abnormalities found in this study were cataract (206 eyes; 64.78% (95% CI 59.53-70.03)), which consisted of immature cataracts (164; 51.57%), mature cataracts (15; 4.72%) and pseudophakic/aphakic eyes (27; 8.5%). CCC (135 eyes; 42.5% (95% CI 37.02-47.88)) consisted of eyes with conjunctival deposit only (74; 23.3%) and both conjunctival and corneal deposit (61; 19.2%) (**Table 3**).

Table 3. Ocular Characteristic Findings in Hemodialysis Patients (N=318 Eyes)

Characteristic	Value
BCVA (LogMAR)	
Mean±SD	0.46±0.71
Median (Range)	0.20 (0.00-3.00)
Frequencies for Conjunctival and Corneal Calcification (n,%)	
No deposits	183 (57.5)
Conjunctival deposit only	74 (23.3)
Conjunctival and corneal deposit	61 (19.2)
Frequencies for Cataract (n,%)	
No cataract	112 (35.2)
Immature cataract	164 (51.6)
Mature cataract	15 (4.7)
Pseudophakic and aphakic	27 (8.5)
Frequencies for Posteriors Segment Findings (n,%)	
Normal	110 (34.6)
Non-Proliverative Diabetic Retinopathy	28 (8.8)
Proliverative Diabetic Retinopathy	21 (6.6)
Hypertensive Retinopathy grade 0-2	73 (23)
Hypertensive Retinopathy grade 3-4	10 (3.1)
Central Retinal Vein Occlusion	2 (0.6)
Others (macular abnormality)	18 (5.7)
Difficult to evaluate (media opacity)	56 (17.6)

Table 4 shows the measure of association between cataract and predictors. In a simple logistic regression model, there was no statistically significant association between cataract and any predictor, except for diabetes mellitus. However, after adjusting for all other variables, higher education level (adjusted OR 0.17; 95% CI 0.04-0.74; P-value: 0.02), hypertension (adjusted OR 0.15; 95% CI 0.03-0.79; P-value:0.03), diabetes mellitus (adjusted OR 10.49; 95% CI 1.57-70.06; P-value:0.02), elevated blood pressure vs. normal (adjusted OR 0.05; 95% CI 0.003-0.69; P-value:0.03), SBP grade 2 vs. normal (adjusted OR 0.05; 95% CI 0.004-0.67; P-value:0.02), DBP grade 1 vs. normal (adjusted OR 7.44; 95% CI 1.13-48.73; P-value:0.04), and DBP grade 2 vs. normal (adjusted OR 48.47; 95% CI 3.4-692.03; P-value:<0.001) showed significant association with cataract. No statistically significant association between CCC and any predictor was observed (**Table 5**).

Table 4. The Measure of Association Between Cataract and Predictors

Variables	Cataract			
	Crude		*Adjusted	
	OR (95% CI)	P	OR (95% CI)	P
Age (years)				
<40	Reference			
40-49	2.03 (0.20-20.76)	0.55	1.73 (0.19-15.44)	0.62
50-59	3.50 (0.41-29.88)	0.25	2.92 (0.44-19.53)	0.27
60	1.87 (0.18-19.48)	0.60	0.54 (0.04-8.26)	0.66
Sex				
Female	Reference			
Male	0.64 (0.21-1.89)	0.42	0.89 (0.26-3.07)	0.86
Education				
9-years basic education	Reference			
Higher education	0.43 (0.14-1.28)	0.13	0.17 (0.04-0.74)	0.02
Occupation				
Unemployed	Reference			
Employed	0.86 (0.29-2.61)	0.79	0.99 (0.23-4.29)	0.99
HD Period (Years)				
<1	Reference			
1-5	4.73 (0.93-24.17)	0.06	20.19 (0.57-716.65)	0.09
6-10	2.81 (0.35-22.27)	0.33	6.41 (0.28-146.48)	0.25
>10	4.81 (0.37-62.98)	0.23	33.69 (0.34-3376.79)	0.14
Hypertension				
No	Reference			
Yes	0.35 (0.11-1.14)	0.08	0.15 (0.03-0.79)	0.03

Diabetes Mellitus				
No	Reference			
Yes	4.33 (1.37-13.68)	0.01	10.49 (1.57-70.06)	0.02
Body Mass Index (BMI)				
Underweight	Reference			
Normal (18.5-22.9)	1.32 (0.15-11.92)	0.80	1.08 (0.11-10.53)	0.95
Overweight (23-24.9)	1.10 (0.09-13.24)	0.94	1.37 (0.12-15.04)	0.79
Obese (≥ 25)	2.35 (0.26-21.49)	0.45	4.97 (0.47-52.71)	0.18
Systolic Blood Pressure (mmHg)				
Normal	Reference			
Elevated 120-129	0.31 (0.03-3.38)	0.34	0.05 (0.003-0.69)	0.03
Grade 1: 130-139	0.40 (0.06-2.85)	0.36	0.18 (0.03-1.28)	0.09
Grade 2: ≥ 140	0.38 (0.09-1.58)	0.18	0.05 (0.004-0.67)	0.02
Diastolic Blood Pressure (mmHg)				
Normal	Reference			
Grade 1: 80-89	1.32 (0.25-7.04)	0.75	7.44 (1.13-48.73)	0.04
Grade 2: ≥ 90	1.67 (0.32-8.60)	0.54	48.47 (3.39-692.03)	<0.01

*Adjusted: adjusted for all variables

Table 5. The Measure of Association Between Conjunctival and Corneal Calcification (CCC) and Predictors.

Variables	Conjunctival and Corneal Calcification (CCC)			
	Crude		*Adjusted	
	OR (95% CI)	P	OR (95% CI)	P
Age (years)				
<40	Reference			
40-49	2.02 (0.77-5.31)	0.16	1.86 (0.69-4.98)	0.22
50-59	1.31 (0.52-3.32)	0.57	1.23 (0.45-3.33)	0.68
60	0.87 (0.30-2.48)	0.79	0.79 (0.25-2.51)	0.69
Sex				
Female	Reference			
Male	1.24 (0.67-2.28)	0.49	0.99 (0.44-2.22)	0.98
Education				
9-years basic education	Reference			
Higher education	1.19 (0.62-2.29)	0.60	0.86 (0.42-1.76)	0.68
Occupation				
Unemployed	Reference			
Employed	1.65 (0.90-3.03)	0.11	1.44 (0.62-3.33)	0.39
HD Period (Years)				
<1	Reference			
1-5	1.30 (0.66-2.59)	0.45	1.27 (0.59-2.68)	0.54
6-10	0.88 (0.34-2.28)	0.80	0.75 (0.28-1.99)	0.56
>10	1.54 (0.35-6.80)	0.57	1.47 (0.29-7.26)	0.64
Hypertension				
No	Reference			
Yes	1.04 (0.47-2.29)	0.92	1.11 (0.46-2.66)	0.82
Diabetes Mellitus				
No	Reference			
Yes	0.91 (0.48-1.72)	0.77	0.91 (0.43-1.93)	0.79
Body Mass Index (BMI)				
Underweight	Reference			
Normal (18.5-22.9)	1.43 (0.48-4.26)	0.53	1.33 (0.38-4.56)	0.65
Overweight (23-24.9)	1.16 (0.34-3.92)	0.81	1.03 (0.26-3.99)	0.97
Obese (≥ 25)	1.57 (0.50-4.99)	0.44	1.53 (0.41-5.74)	0.53

Systolic Blood Pressure (mmHg)				
Normal	Reference			
Elevated 120-129	0.75 (0.19-3.01)	0.68	0.87 (0.19-4.06)	0.86
Grade 1: 130-139	1.29 (0.34-4.84)	0.71	1.66 (0.41-6.79)	0.48
Grade 2: ≥ 140	1.08 (0.38-3.03)	0.89	1.15 (0.33-3.97)	0.82
Diastolic Blood Pressure (mmHg)				
Normal	Reference			
Grade 1: 80-89	0.74 (0.32-1.73)	0.49	0.70 (0.25-1.93)	0.49
Grade 2: ≥ 90	0.86 (0.37-1.99)	0.72	0.82 (0.27-2.45)	0.72

*Adjusted: adjusted for all variables

DISCUSSION

Cataract and CCC were found to be the major ocular abnormalities in HD patients in this study. Among all predictors, diabetes and DBP showed to be the major contributors to cataract. However, none of the predictors showed a significant relationship with CCC. The odds ratios in the DBP categories showed a dose-response relationship in which DBP grade 1 was 7.4 times more likely to have the odds of having cataract; higher DBP (≥90 mmHg) showed 48.5 times greater odds of having cataract as compared to normal DBP (<80 mmHg). Further, DM was found to be associated with 10.5 times higher odds of having cataract as compared to subjects with no DM. Higher education level (>9 years of basic compulsory education) showed a protective effect against cataract in this study. Despite its significance, we assume that the association between cataract and higher education level in this study could be due to a chance finding and not necessarily causal relationship.

Furthermore , hypertension and SBP showed unexpected results that were protective against cataract. This may be due to the selection bias and blood pressure error measurement based on single measurement. On the other hand, age, gender, occupation, HD period, and BMI showed no significant relationship with cataract. This may indicate that unlike the general population, renal impairment itself along with certain related treatments increase the risk of cataract and corneoscleral calcification.[25,26] Moreover, chronic kidney disease is also an independent risk factor.[27] Further, the relationship between BMI and the risk of cataract is controversial across observational studies.[28] HD period and BMI in this study demonstrated no significant relationship with cataract or CCC, which may be due to different etiology and levels of severity of the disease, different levels of phosphate calcium, and varying impact of the treatment on each patient. The non-significant association between CCC and any predictor needs to be explored further.

The high prevalence of ocular abnormalities among HD patients based on several studies [3,29,30] has been revealed in this study. The prevalence of cataract in HD patients varies between 11.1%-61.4%.[4,6,7,11,29] Increased cataracts in CKD patients may represent common risk factors, including age, smoking, high blood pressure, diabetes, dyslipidemia, and obesity.[27] Wang et al., found the increase of prevalence of cataract in CKD patients after controlling for age, hypertension, and diabetes mellitus in a large cross-sectional population-based study in Taiwan.[31] The prevalence of CCC in HD patients among cross-sectional studies varies between 1.4%-32.2%.[4,6,7] Moreover, it is possible for individuals with severe kidney disease and ESRD to develop metastatic calcification on the eyelid margins, conjunctival tissue, and cornea.[27] Kianersi et al. found that the duration of dialysis has a significant association with conjunctival calcification but not with corneal calcification or cataract.[7] While a longitudinal study by Hsiao et al. demonstrated that HD period was associated with the degree of calcification.[12]

Hypertension, followed by diabetes mellitus, was the most prevalent of HD etiologies in this study, which showed that there has been an epidemiological transition in the etiology of ESRD in Indonesia, where glomerulonephritis

was the most prevalent etiology, approximately 10 years ago.[2] Based on previous studies, the most prevalent renal disorders with ocular consequences are hypertension and diabetes.[7,25,26,29] The presence of diabetes and high blood pressure were found to be associated with a four-fold increase in cataract.[32] Furthermore, another previous study showed that SBP but not DBP or hypertension were associated with the occurrence of cataract.[33] This finding was inconsistent with our findings in that both SBP and DBP showed significant association with cataract. However, the error measurement of blood pressure may have impacted the association.

Cataract is a multifactorial disease. There are several risk factors for cataracts, including diabetes mellitus,[34–36] hypertension,[37] systemic corticosteroid usage, smoking as well as UV radiation exposure.[36] The risk of cataract formation is significantly enhanced in a population with hypertension,[37] due to the elevation of inflammatory cytokines detected in hypertension patients.[38,39] Due to a wide range of outcomes in different research, it is unclear if CKD contributes to the development or progression of cataract.[25] Imbalances of the fluid and electrolytes equilibrium,[8] underlying comorbidities in individuals with renal failure,[8,40] and the treatment being administered such as steroid,[26] may enhance the risk of ocular problems in patients. Possible explanations for the development of cataract in HD patients include accumulation of toxic metabolites and calcium deposits in the lens,[11,27] oxidative stress, inflammation and vitamin D deficiency.[27] On the other hand, the pathogenesis for ocular calcifications is not entirely known. Some studies explained its association to secondary hyperparathyroidism,[11] higher levels of serum Ca-P,[6,12,40] serum copper, cystatin, intact parathyroid hormone, and vitamin D.[40]

Patients on HD are vulnerable subjects with high-risk ocular abnormalities, yet face difficulties in getting access to eye treatment and services. This study was conducted in a HD unit and the patients were able to decide the best timing for their eye screening according to their convenience, before or after the HD session. The majority of these patients found this setting helpful, even though most of them do not acknowledge the necessity of an eye care examination and do not consider eye screening as a top priority for HD patients. The results of this study emphasize that regular eye examination is needed for early diagnosis, evaluating the existence and prevention of HD-related eye manifestations. Further, to obtain better data to support integrated health services to conduct a thorough eye examination in HD unit and to provide clinical guidelines for standard ophthalmology screening among HD patients.

There are several limitations to this study. First, we could not assume the causal relationship between the outcome and any predictor due to the cross-sectional nature of the study. Second, the patients had ocular examinations at different times (before or after HD session), depending on their willingness and the strength of their body to undergo thorough ocular examination. This may have impacted the result of some eye measurements despite that some studies found no significant influence between pre- and post-HD sessions. Third, cataract was determined when opacification was evident and was not graded in detail, as only immature and mature cataract were obtained. Finally, certain data from electronic medical records were unavailable. Ideally, to corroborate the findings, a longitudinal study with other centers is needed to assess the incidence and risk factors of ocular diseases in the HD population. Further, performance knowledge and awareness studies toward ocular abnormalities among HD patients will be beneficial.

CONCLUSION

High prevalence of ocular abnormalities among HD patients were revealed in this study. Cataract and CCC were found to be the major ocular abnormalities in HD patients and are potentially reversible if addressed early. Hence, integrated health services involving ophthalmology and HD unit should be pursued. In addition, awareness among HD patients regarding potential ocular abnormalities related to renal disease, especially with diabetes mellitus, hypertension, and poor metabolic

control, should be raised. Furthermore, the importance of detailed eye screening despite all limitations among HD patients should be emphasized to prevent further complications and perform necessary treatment before the occurrence of visual loss.

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