

Risk factors and complications of cataract disease in type two diabetic patients in Taif city

Amal Saleh Alfaqeeh (1)
Rawan Yasseen Bamjboor (1)
Ameerah Saleh Bajaber (1)
Ayman Abdelbaky Atalla (2)
Fatima Moeesh Altalhi (1)
Futoon Abdullah Aljouid (1)
Ohoud Owayedh Almutairi (1)

(1) Medical student, Faculty of Medicine, Taif University, Saudi Arabia

(2) Department of Family Medicine, Faculty of Medicine, Taif University, Saudi Arabia

Corresponding author:

Amal Saleh Alfaqeeh

Taif University,

Saudi Arabia

Email: amal.sf16@gmail.com

Received: July 2020; Accepted: August 2020; Published: September 1, 2020.

Citation: Amal Saleh Alfaqeeh et al. Risk factors and complications of cataract disease in type two diabetic patients in Taif city. World Family Medicine. 2020; 18(9): 14-23 DOI: 10.5742MEWFM.2020.93851

Abstract

Diabetic retinopathy has been regarded as the most common cause of visual loss, and diabetes mellitus is also known as an important risk factor for cataract. The present study aimed to detect the risk factors and complications of cataract in type two diabetic patients in Taif city. A retrospective study was done from April 2019 to April 2020 at the diabetic tertiary care hospital in Taif city. Medical records of 110 diabetic patients were reviewed. A predesigned checklist was prepared to collect demographic data, data about diabetes mellitus, and data about cataract and its risk factors and complications. Of the studied patients, 86.4% had DM type 2, 63.6% had a DM duration more than 10 years, 50% were using antihyperglycemic agents as DM medication, 87.3% reported that they were committed to the medication used, and 50.9% had HTN. About half of the participants (49.1%) were exposed to the sun, and 65.5% reported exposure to radiations.. About 45% of the participants (45.5%) reported that they had a family history of cataract, of whom 77.6% reported that those having cataract were 1st degree relatives.

Conclusion: Long duration of DM, no commitment to medication, radiation exposure and aging were risk factors for cataract in diabetic patients. Diabetic patients should be continuously evaluated by an ophthalmologist.

Key words: risk, complications, cataract, diabetes, Taif

Introduction

Cataract is the primary cause of blindness worldwide [1]. It is defined as a decrease in the transparency of the crystalline lens and can be further differentiated into nuclear, cortical, or posterior subcapsular cataract (PSC) [2]. Diabetes mellitus has been reported as the most critical factor causing visual loss. Among the various complications of diabetes mellitus in the eyes, diabetic retinopathy has been regarded as the most common cause of visual loss [3]. Diabetes mellitus is also known as an important risk factor for cataract [3].

In a study performed to quantitatively evaluate the prevalence and risk factors of cataracts in Korean patients with type 2 diabetes mellitus, the duration of diabetes was the most significant risk factor for cataracts in patients with diabetes [3]. This finding indicates that the accumulated effect of hyperglycemia is related to lens transparency in patients with diabetes [3].

Another study done in the UK on newly diagnosed diabetes patients (≥ 40 years) found that diabetes is associated with an approximately two-fold increased detection rate of cataract. The risk of cataract associated with diabetes is highest at younger ages [4]. Patients with diabetic macular edema are at an increased risk for cataract as well as patients with long-standing diabetes [4].

Another study done in 2004 in Iran showed that the age-adjusted incidence rate of cataract was 20% greater among insulin-treated than non-insulin-treated type 2 diabetes mellitus clinic attenders and it increased with age [5]. Another study done in 2010 in India found that mixed cataracts were more common than monotype ones [6]. The prevalence of cataract was higher in women [6]. The risk factors for any type of cataract were increasing age, macroalbuminuria and increasing glycosylated hemoglobin; higher hemoglobin was the protective factor [6]. The risk factors for nuclear cataract included increasing age and high serum triglyceride [6]. For cortical cataract, increasing age and poor glycemic control were the risk factors; increasing hemoglobin was the protective factor [6].

For posterior subcapsular cataract, the risk factors included increasing age, being of the female sex, employment and duration of diabetes [6]. Tobacco smoking is also associated with dysfunctional tear syndrome, cataracts, and likely contributes directly to the development of diabetes mellitus [7].

Previous studies have found that DM is associated with early and rapid development of cataracts and diabetic patients are more likely to have cortical and posterior subcapsular cataracts [8]. Other studies found that the presence of cataracts were significant factors contributing to visual impairment and blindness in diabetics [9,10].

A study done in southern Saudi Arabia showed that the prevalence of bilateral blindness $< 3/60$ was 3.3% [11]. Cataract was the leading cause of blindness (58.6%); followed by posterior segment diseases (20%), which

included DR (7; 3.3%) [11]. The prevalence of sight-threatening diabetic retinopathy was 5.7%. Unlike in non-diabetic eyes, choroidal thickness in diabetic patients decreased following cataract surgery [12].

Another study was done in KSA in 2011 to estimate the prevalence of visual impairment and identify its causes and associated factors among the adult population attending primary health care (PHC) centers in Aljouf province, in northern Saudi Arabia. This study found that the main cause among patients who had chronic disease was diabetic retinopathy (39.1%) followed by cataract (32.6%) [13].

A recent Saudi study was done to determine the prevalence, patterns and predictors of diabetes complications among patients with type 2 diabetes. In those patients diabetic retinopathy was found among 16.7% of them [14]. The aim of this study was to detect the risk factors and complications of cataract in type two diabetic patients in Taif city.

Subjects and methods

Study design: The present study was a retrospective study.

Study duration: 1 year, from April 2019 to April 2020.

Study settings: This study was done at the diabetic tertiary care hospital (King Abdelaziz Specialized Hospital (KASH) in Taif city, Saudi Arabia.

Sampling methodology: Medical records of all diabetic patients were reviewed. The inclusion criteria were both genders of all ages who attended the diabetic centre of KASH at the time of the study. The excluding criteria were being non-diabetic patients, type 1 diabetic patients and non-cataract patients of type 2 diabetic patients.

Tools of data collection: A predesigned checklist was prepared to collect 3 sets of data from the medical records: 1) demographic data (age, gender, etc), 2) data about diabetes mellitus, 3) data about cataract and its risk factors and complications.

Statistical design: Data was collected and analysed using the SPSS statistical program version 20. Qualitative data was expressed as frequencies and percentages. Chi-squared test was used to assess the relationship between variables. A p-value of less than 0.05 was considered significant.

Results

In the present study, 87.3% of the participants were in the age group less than 20 years, 52.7% were females, and 96.4% were of Saudi nationality. Of the participants, 12.7% were smokers and 50% of the smokers smoked less than 10 cigarettes/day and 71.4% had a smoking duration of more than 5 years. About half of the participants (48.2%) had a smoker as a family member and 25.5% were passive smokers (Table 1).

Table 1: Distribution of the studied patients according to their demographic characteristics, and smoking status (No.110)

Variable	No. (%)
Age	
more than40	5 (4.5)
20-40	9 (8.2)
less than20	96 (87.3)
Gender	
male	52 (47.3)
female	58 (52.7)
Nationality	
Saudi	106 (96.4)
non-Saudi	4 (3.6)
Smoking	
No	96 (87.3)
Yes	14 (12.7)
No. of cigarette\day (No.:14)	
less than10 cigarettes	7 (50)
10-20 cigarettes	5 (35.7)
more than20 cigarettes	2 (14.7)
Smoking duration	
5 years or less	4 (28.6)
more than5 years	10 (71.4)
Smoker in family members	
no	57 (51.8)
yes	53 (48.2)
Passive smoking	
no	82 (74.5)
yes	28 (25.5)

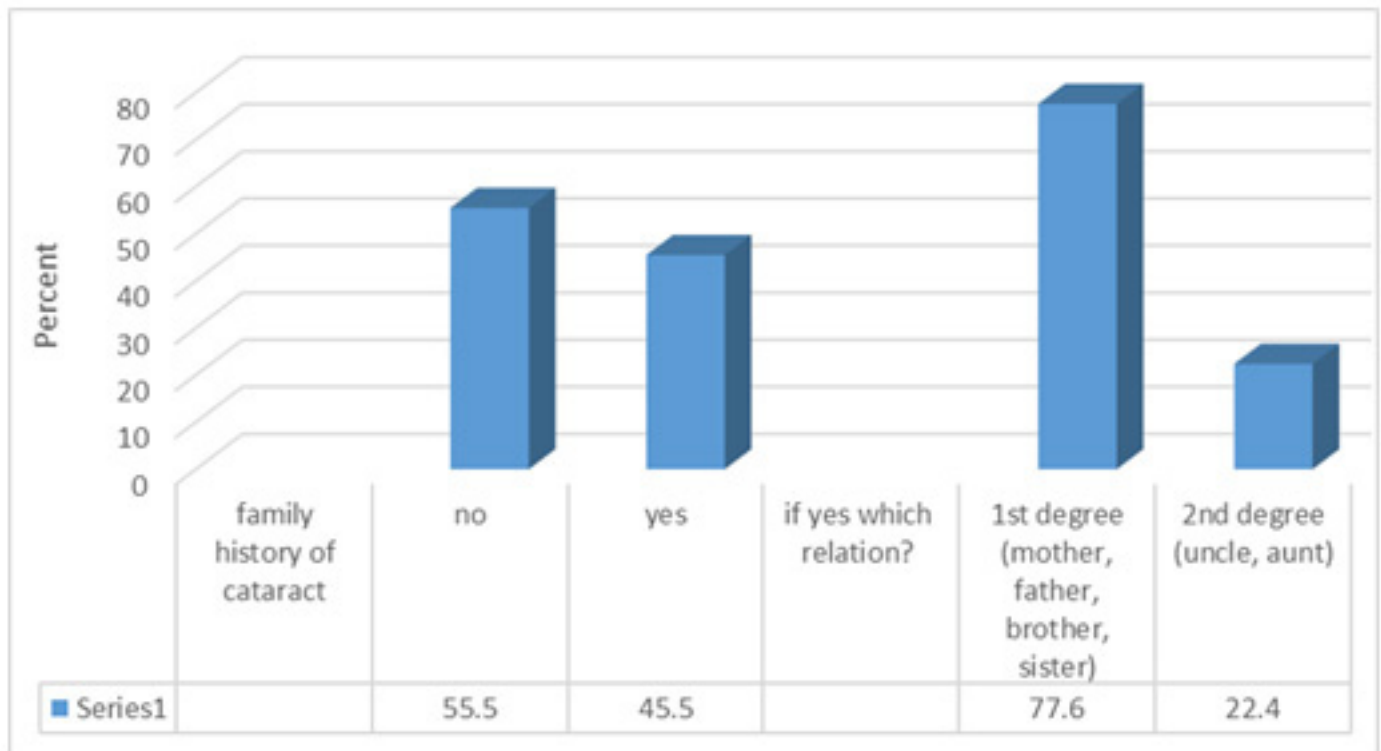
Of the studied diabetic patients, 86.4% had DM type 2, 63.6% had a DM duration more than 10 years, 50% were using antihyperglycemic agents such as DM medication, 87.3% reported that they were committed to the medication used, and 50.9% had HTN. About half of the participants (49.1%) were exposed to the sun, and 65.5% reported exposure to radiation (Table 2).

Table 2: Distribution of the studied patients according to DM type, duration, medication used, medication commitment, exposure to radiation and sun and presence of HTN (No.110)

Variable	No. (%)
DM type	
type (1)	15 (13.6)
type (2)	95 (86.4)
Duration of DM	
less than 5 years	19 (17.3)
5-10 years	21 (19.1)
more than 10 years	70 (63.6)
DM medication used	
Antihyperglycemic agents	55 (50)
Insulin	52 (47.3)
Lifestyle change	3 (2.7)
medication commitment	
No	14 (12.7)
Yes	96 (87.3)
Exposure to radiation	
no	28 (34.5)
yes	72 (65.5)
Sun exposure	
no	56 (50.9)
yes	54 (49.1)
if yes which time? (No.=54)	
from 7 am to 10 am	30 (55.6)
from 11 am to 1 pm	9 (16.7)
after 1 pm	9 (16.7)
from 5 pm until sunset	6 (11.1)
HTN	
no	54 (49.1)
yes	56 (50.9)

About 45% of the participants (45.5%) reported that they had a family history of cataract, of whom 77.6% reported that those having cataract were 1st degree relatives (Figure 1).

Figure 1: Distribution of the studied patients according to the presence of family history of cataract, and the type of family relation with those having cataract in the family (No. =110)



Of the participants, 66.4% had chronic headache, 30% had myopia, 25.5% had hyperopia, and 49.1% had previous correction surgery (Table 3).

Table 3: Distribution of the studied patients according to the presence of chronic headache, myopia, hyperopia and correction surgery (No. =110)

Variable	No. (%)
chronic headache	
no	73 (66.4)
yes	37(33.6)
myopia or hyperopia	
myopia	33 (30)
hyperopia	28(25.5)
non	49 (44.5)
correction surgery	
no	56 (50.9)
yes	54 (49.1)
If yes what were the outcomes (No.=54)	
progress	33 (61.1)
no difference	16 (29.6)
regress	5 (9.3)

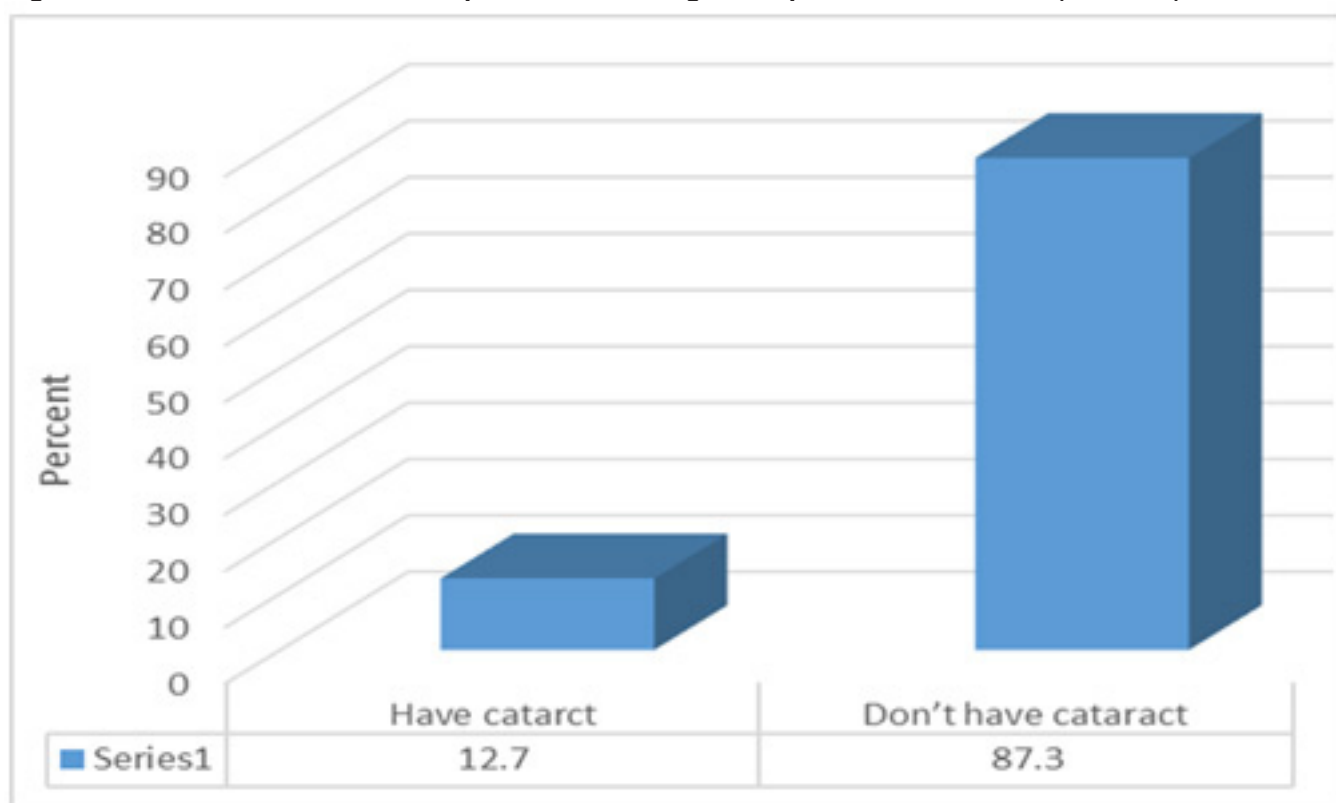
According to the presence of eye complications, 40.9% of patients had difficulty in reading, 27.3% had difficulty in night driving, and 34.5% had difficulty in seeing things correctly. Of them, 11.8% had poor vision, 6.4% had diplopia, 0.9% had difficulty coordinating clothes, 54.5% had blurred vision, and 3.6% had lack of vision in the extremities (Table 4).

Table 4: Distribution of the studied patients according to the presence of eye complications (No.=110)

Variable	No. (%)
Any difficulty in reading?	
no	65 (59.1)
yes	45 (40.9)
Any difficulty in night driving?	
no	80 (72.7)
yes	30 (27.3)
Any difficulty in seeing things correctly?	
no	72 (65.5)
yes	38 (34.5)
Any poor vision?	
no	97 (88.2)
yes	13 (11.8)
Any diplopia?	
no	103 (93.6)
yes	7 (6.4)
Any difficulty coordinating clothes?	
no	109 (99.1)
yes	1 (0.9)
Any blurred vision?	
no	50 (45.5)
yes	60 (54.5)
Any lack of vision in the extremities?	
no	106 (96.4)
yes	4 (3.6)

Figure 2 shows that of the studied diabetic patients, 14 (12.7%) were diagnosed with cataract.

Figure 2: Distribution of the studied patients according to the presence of cataract (No. =110)



Of the cataract patients, 8.9% had difficulty in reading, 16.7% had difficulty in night driving, 18.4 had difficulty in seeing things correctly, 23.1% had poor vision, 14.3% had diplopia, 18.3% had blurred vision, and 25% had lack of vision in the extremities. None of the participants suffered difficulty coordinating clothes. Only (64.3%) of patients who suffered from cataract had cataract surgery, of them 44.4% suffered eye erythema, 33.3% suffered eye itching and discharge, and 22.2% suffered haziness at the middle of their vision after surgery (Table 5).

Table 5: Distribution of the presence of eye complications among patients diagnosed with cataract (No. =14)

Variable	No. (%)
Any difficulty in reading? yes	4 (8.9)
Any difficulty in night driving? yes	5 (16.7)
Any difficulty in seeing things correctly? yes	7 (18.4)
Any poor vision? yes	3 (23.1)
Any diplopia? yes	1 (14.3)
Any difficulty coordinating clothes? yes	0 (0.0)
Any blurred vision? yes	11 (18.3)
Any lack of vision in the extremities? yes	1 (25)
Had cataract surgery No	5 (35.7)
Yes	9 (64.3)
If you had a cataract operation, did you complain of any one of these after the operation, choose all the right answers:	
- Eye erythema	4 (44.4)
- Eye itching	3 (33.3)
- Eye swelling	0 (0.0)
- Eye discharge	3 (33.3)
- Haziness at the middle of the vision	2 (22.2)
- Loss of vision completely	0 (0.0)

Table 6 shows that cataract prevalence was significantly higher among those with an age more than 40 years, those having DM duration more than 10 years, among those having lifestyle change as a DM therapy, and among those with no medication commitment ($p < 0.05$). On the other hand, a non-significant difference was found between those having cataract and those who had not according to their gender and DM type ($p > 0.05$).

Table 7 shows that cataract prevalence was significantly higher among those who had exposure to radiation ($p < 0.05$). On the other hand, a non-significant difference was found between those having cataract and those have not according to smoking, exposure to sun, presence of HTN, and family history of cataract ($p > 0.05$).

Table 6: Relationship between the presence of cataract and age, gender, DM type, duration, medication used, and medication commitment

Variable	cataract	cataract	χ^2 test	p-value
	No. (%)	No. (%)		
Age				
more than 40	2 (4.0)	3 (6.0)	11.76	0.003
20-40	7 (77.8)	2 (22.2)		
less than 20	87 (90.6)	9 (9.4)		
Gender				
male	45 (86.5)	7 (13.5)	0.04	0.82
female	51 (87.9)	7 (12.1)		
DM type				
type (1)	11 (73.3)	4 (26.7)	3.03	0.08
type (2)	85 (89.5)	10 (10.5)		
Duration of DM				
less than 5 years	18 (94.7)	1 (5.3)	6.16	0.04
5-10 years	21 (100)	0 (0.0)		
more than 10 years	57 (81.4)	13 (18.6)		
DM medication used				
anti-hyperglycemic agents	50 (90.9)	5 (9.1)	8.53	0.014
insulin	45 (86.5)	7 (13.5)		
Lifestyle change	1 (33.3)	2 (66.7)		
Medication commitment				
No	9 (64.3)	5 (35.7)	7.63	0.006
Yes	87 (90.6)	9 (9.4)		

N.B.: χ^2 = Chi-square test

Table 7: Relationship between the presence of cataract and smoking, exposure to radiation and sun, presence of HTN, and family history of cataract

Variable	Don't have cataract	Have cataract	χ^2 test	p-value
	No. (%)	No. (%)		
Smoking				
No	86 (89.6)	10 (10.4)	3.62	0.05
Yes	10 (71.4)	4 (28.6)		
Exposure to radiation				
no	37 (97.4)	1 (2.6)	5.32	0.02
yes	59 (81.9)	13 (18.1)		
Sun exposure				
no	49 (87.5)	7 (12.5)	0.005	0.94
yes	47 (87)	7 (13)		
HTN				
no	49 (90.7)	5 (9.3)	1.14	0.28
yes	47 (83.9)	9 (16.1)		
Family history of cataract				
no	55 (90.2)	6 (9.8)	1.03	0.31
yes	41 (83.7)	8 (16.3)		

N.B.: χ^2 = Chi-square test

Discussion

Cataract is the primary cause of blindness worldwide [1]. Diabetes mellitus is known as an important risk factor for cataract [3]. A previous study was done in Abha city in Saudi Arabia and demonstrated that retinopathy is a common complication of diabetes in diabetic patients at Abha and Aseer region and that the situation is no different from other regions of Saudi Arabia [15].

The present investigation aimed to examine the risk factors and complications of cataract on type 2 diabetic patients in Taif city, Saudi Arabia. Cataract prevalence was significantly higher among those with an age more than 40 year, those having a DM duration more than 10 years, among those having lifestyle change as a DM therapy, and among those with no medication commitment. The duration of DM was reported to be a risk factor of diabetic retinopathy in other studies [16]. Another study demonstrated that cataract risk increased with increasing diabetes duration for 10 years or more [17].

Other studies revealed that the longer duration of diabetes was associated with increased frequency of both cortical cataracts and cataract surgery [18].

In the present study, cataract prevalence was significantly higher among those with an age more than 40 years. This finding agrees with reports in an Indian study, where greater age at baseline was a risk factor for cumulative incidence and progression of most types of cataract [19]. The same was observed in other studies where risk factors of cataract among type 2 diabetic included age [20]. On the contrary, the risk of cataract associated with diabetes is higher at younger ages in another study [21].

In the present study, a non-significant relationship was found between the occurrence of cataract among the studied patients and the presence of HTN. In a study done in Sudan, the concurrent presence of chronic medical disorders such as hypertension, ischaemic heart disease, chronic kidney disease and dyslipidaemia amplifies the risk for the development of microvascular sequelae [22]. And previous studies have found that 24.9% of type 2 diabetic patients had a 10-year cumulative incidence of cataract surgery [23].

In a national study done in Jazan, Saudi Arabia, neuropathy was the most prevalent micro-vascular complication and hypertension and obesity were very significant predictors of diabetes complications [24].

Poor pupillary dilatation can be seen in diabetic patients as the result of damage to pupillary parasympathetic supply and elevated prostaglandin levels [25]. This means that pupil dilation is also a problem for these patients. The effects of DM on the ocular surface include neurogenic effects (subbasal nerve abnormalities) and impaired corneal stem cell and epithelial cell division, which can result in keratoepitheliopathy and leads to corneal epithelial defects/abrasions, which may heal slowly [26,27].

It has also been shown that corneal endothelial cell loss is higher in people with diabetes than in non-diabetics [23,28]; this means that routine evaluation of diabetic patients using specular microscopy is recommended. Moreover, surgeons should take greater care to reduce endothelial stress during surgery [29].

In the present study, cataract patients had complications such as difficulty reading (40.9%), difficulty night driving (27.3%), difficulty seeing correctly (34.5%), poor vision (11.8%), diplopia (6.4%), lack of peripheral vision (3.6%) and difficulty coordinating clothes (0.9%). Other complications were lack of extremities vision (25%), poor vision (23.1%), difficulty seeing correctly (18.4%), blurred vision (18.3%), difficulty night driving (16.7%), diplopia (14.3%) and difficulty reading (8.9%).

Progression of retinopathy after cataract surgery is another problem in diabetic patients [30]. The duration and complexity of cataract surgery are the main risk factors for progression of retinopathy [31]; it is therefore important to reduce the time and complexity of the surgery.

Among patients who did cataract surgery the most common complications were erythema (44.4%), eye itching (33.3%), discharge (33.3%) and haziness at the middle of the vision (22.2%).

A study done in Turkey reported that patients with diabetes have multiple issues to be evaluated preoperatively, perioperatively and in the postoperative period and these patients can, like other cataract patients without diabetes, recover excellent vision [32].

Limitations

Limitations of the present study were the small sample size and some difficulties related to the administrative aspects to collect data from medical records at the studied center.

Conclusion

Of the studied diabetic patients, 12.7% were diagnosed with cataract. Cataract prevalence was significantly higher among those with an age more than 40 years, those having a DM duration more than 10 years, among those having lifestyle change as a DM-therapy and among those with no medication commitment. Cataract prevalence was significantly higher among those who had exposure to radiation. Diabetic patients should be continuously evaluated by an ophthalmologist. The study calls for future longitudinal studies to identify modifiable risk factors that could prevent or delay cataract formation.

Acknowledgement

The authors would like to express their thanks to King Abdulaziz hospital for helping and facilitating in data collecting and allowing all avenues to complete the research. We also would like to thank Dr. Ayman Abdelbaky, Department of Family Medicine, Faculty of Medicine, Taif University, for his guidance and support as a supervisor in completing the research. The authors

extend their gratitude to Hanan Rizieq Alhuthali, Razan Fahad Alwagdani, Ameerah Mohammed Almalki, Aeshah Dakhel Alrabie, Rahma Abdullah Algethami and Maha Faiz Albogami, medical students, Taif University for their special efforts in data collection.

References

- Bourne RRA, Stevens GA, White RA, Smith JL, Flaxman SR, Price H, et al. Causes of Vision Loss Worldwide, 1990-2010: A Systematic Analysis. *Lancet Glob Health*. 2013;1(6): e339-49.
- Asbell PA, Dualan I, Mindel J, Brocks D, Ahmad M, Epstein S. Age-related cataract. *Lancet*. 2005;12-18;365(9459):599-09
- Seong Il Kim, MD and Sung Jin Kim, MD. Prevalence and Risk Factors for Cataracts in Persons with Type 2 Diabetes Mellitus. *Korean J Ophthalmol*. 2006; 20(4): 201-4.
- Becker C, Schneider C, Aballéa S, Bailey C, Bourne R, Jick S, et al. Cataract in patients with diabetes mellitus—incidence rates in the UK and risk factors. *Eye*. 2018; 32:1028-35
- Janghorbani M, Amini M. Cataract in type 2 diabetes mellitus in Isfahan, Iran: Incidence and risk factors. *Ophthalmic Epidemiol*. 2004;11(5):347-58
- Raman R, Pal SS, Adams JSK, Rani PK, Vaitheeswaran K, Sharma T. Prevalence and Risk Factors for Cataract in Diabetes: Sankara Nethralaya Diabetic Retinopathy Epidemiology and Molecular Genetics Study, Report No. 17.. *Invest Ophthalmol Vis Sci*.2010;51(12):6253-61
- Stone DU. Tobacco smoking and blindness - The ignored epidemic. *Saudi J Ophthalmol*. 2016;30(3): 149.
- Chiang PP, Lamoureux EL, Zheng Y, Tay WT, Mitchell P, Wang JJ, et al. Frequency and risk factors of non-retinopathy ocular conditions in people with diabetes: the Singapore Malay Eye Study. *Diabet Med*. 2013;30(2):e32-40.
- Klein R, Lee KE, Gangnon RE, Klein BE. The 25-year incidence of visual impairment in type 1 diabetes mellitus the Wisconsin epidemiologic study of diabetic retinopathy. *Ophthalmology*. 2010;117(1):63-70.
- Rani PK, Raman R, Gella L, Kulothungan V, Sharma T. Prevalence of visual impairment and associated risk factors in subjects with type II diabetes mellitus: Sankara Nethralaya diabetic retinopathy epidemiology and molecular genetics study (SN-DREAMS, report 16). *Middle East Afr J Ophthalmol*. 2012;19(1):129-34.
- Hajar S, Al Hazmi A, Wasli M, Mousa A, Rabi M. Prevalence and Causes of Blindness and Diabetic Retinopathy in Southern Saudi Arabia. *Saudi Med J*. 2015; 36(4):449-55.
- Torabi H, Sadraei M, Jadidi K, Alishiri A. Choroidal Thickness Changes Following Cataract Surgery in Patients With Type 2 Diabetes Mellitus. *J Curr Ophthalmol*. 2018 ; 11;31(1):49-54.
- Al-Shaalin FF, Bakrman MA, Ibrahim AM, Aljoudid AS. Prevalence and causes of visual impairment among Saudi adults attending primary health care centers in northern Saudi Arabia. *Ann Saudi Med*. 2011;31(5): 473-80.
- Albasheer OB, Sani M, Abbas A, Alfaifi M, Najmi M, Hakami K, et al. Prevalence, patterns and predictors of diabetes complications among patients with type 2 diabetes at Jazan Diabetic Centre, Saudi Arabia. *Medical science*. 2020; 24(101):83-9.
- Ahmed RA, Khalil SN, Al-Qahtani MA. Diabetic retinopathy and the associated risk factors in diabetes type 2 patients in Abha, Saudi Arabia. *J Fam Community Med*. 2016;23:18-24.
- Lee R, Y. Wong T, Sabanayagam C. Epidemiology of diabetic retinopathy, diabetic macular edema and related vision loss. *Eye and Vision*. 2015;2:17-25.
- Becker C, Schneide, C, Aballéa S, Bailey C, Bourne R, Jick S, et al. Cataract in patients with diabetes mellitus-incidence rates in the UK and risk factors. *Eye*. 2018;32:1028-35
- Klein BE, Klein R, Lee KE. Diabetes, cardiovascular disease, selected cardiovascular disease risk factors, and the 5-year incidence of age-related cataract and progression of lens opacities: the Beaver Dam Eye Study. *Am J Ophthalmol*. 1998; 126: 782-90
- Srinivasan S, Raman R, Swaminathan G, Ganesan S, Kulothungan V, Sharma T. Incidence, progression, and risk factors for cataract in type 2 diabetes. *Invest Ophthalmol Vis Sci*. 2017;58:5921-29
- Laitinen A, Laatikainen L, Harkanen T, Koskinen S, Reunanen A, Aromaa A. Prevalence of major eye diseases and causes of visual impairment in the adult Finnish population: a nationwide population-based survey. *Acta Ophthalmol*. 2010;88:463-71.
- Harding JJ, Egerton M, van Heyningen R, Harding RS. Diabetes, glaucoma, sex, and cataract: analysis of combined data from two case control studies. *Br J Ophthalmol*. 1993;77:2-6.
- Husseina M, Menasrib S. Prevalence of Microvascular Complications in Type 2 Diabetics Attending a Primary Healthcare Centre in Sudan. *Int J Diabetes Metab*. 2019;10:1159.
- Shih KC, Lam KS, Tong L. A systematic review on the impact of diabetes mellitus on the ocular surface. *Nutr Diabetes*. 2017; 7: e251
- Albasheer OB, Sani M, Abbas A, Alfaifi M, Najmi M, Hakami K, et al. Prevalence, patterns and predictors of diabetes complications among patients with type 2 diabetes at Jazan Diabetic Centre, Saudi Arabia. *Medical Science*. 2020; 24(101): 83-9
- Ferrari GL, Marques JL, Gandhi RA, Heller SR, Schneider FK, Tesfaye S, et al. Using dynamic pupillometry as a simple screening tool to detect autonomic neuropathy in patients with diabetes: a pilot study. *Biomed Eng Online*. 2010; 9: 26
- Yoon KC, Im SK, Seo MS. Changes of tear film and ocular surface in diabetes mellitus. *Korean J Ophthalmol*. 2004; 18: 168-74
- Inoue K, Kato S, Ohara C, Numaga J, Amano S, Oshika T. Ocular and systemic factors relevant to diabetic keratoepitheliopathy. *Cornea*. 2001; 20: 798-801
- Morikubo S, Takamura Y, Kubo E, Tsuzuki S, Akagi Y. Corneal changes after small-incision cataract surgery in patients with diabetes mellitus. *Arch Ophthalmol*. 2004; 122: 966-9
- Yang R, Sha X, Zeng M, Tan Y, Zheng Y, Fan F. The influence of phacoemulsification on corneal endothelial cells at varying blood glucose levels. *Eye Sci*. 2011; 26: 91-5
- Henricsson M, Heijl A, Janzon L. Diabetic retinopathy before and after cataract surgery. *Br J Ophthalmol*. 1996; 80: 789-93
- Mittra RA, Borrillo JL, Dev S, Mieler WF, Koenig SB. Retinopathy progression and visual outcomes after phacoemulsification in patients with diabetes mellitus. *Arch Ophthalmol*. 2000; 118: 912-17
- Kiziltoprak H, Tekin K, Inanc M, Goker YS. Cataract in diabetes mellitus. *World J Diabetes*. 2019; 10(3): 140-53