Open Journal of Ophthalmology, 2016, 6, 70-79
Published Online May 2016 in SciRes. http://www.scirp.org/journal/ojoph
http://dx.doi.org/10.4236/ojoph.2016.62010

Prevalence and Associations of Pseudoexfoliation Glaucoma in a Group of Tertiary Eye Care Facilities in Southwest Nigeria

Chizoba Onochie[1], Obiekwe Okoye[2*], Adeola Onakoya[3], Adunola Ogunro[1], Kunle Hassan[1], Chidi Ihemedu[4], Tade Aribaba[3], Ogugua Okonkwo[1]

[1]Eye Foundation Hospital, Ikeja, Nigeria
[2]Department of Ophthalmology, University of Nigeria Teaching Hospital, Enugu, Nigeria
[3]Guinness Eye Centre, Lagos University Teaching Hospital, Surulere, Lagos, Nigeria
[4]Lily Hospitals, Warri, Nigeria
Email: *eagleobi@yahoo.com

Received 3 March 2016; accepted 3 May 2016; published 6 May 2016

Abstract

Background: Globally, glaucoma is the leading cause of irreversible blindness. Pseudoexfoliation glaucoma is the most common form of secondary open angle glaucoma. Purpose: To determine the prevalence and characteristics of pseudoexfoliation glaucoma (PXG) among newly diagnosed glaucoma patients in Eye Foundation Hospital Ikeja, Guinness Eye Center, Lagos University Teaching Hospital and Deseret Community Vision Institute, Ijebu Imushin. Methods: This hospital-based, descriptive cross-sectional study included newly diagnosed adult glaucoma patients at the glaucoma clinics of three tertiary eye care centers. A study proforma was used to obtain socio-demographic information, medical history, ocular history and relevant findings on ocular and systemic examination. Descriptive and comparative statistical analyses were performed. Values were considered statistically significant where $P < 0.05$. Results: One hundred and forty adult glaucoma patients aged 60.5 ± 11.9 SD years and male to female ratio of 2:1 were examined. The prevalence of PXG among the glaucoma patients was 16.9%. The pseudoexfoliative material (PXM) was most commonly found on the pupil (39%). Common ocular features seen among PXG patients were poor pupillary dilation with mydriatic agents (44%) and Sampaolesi's line in the anterior chamber angle (41%). A higher proportion of PXG patients than primary open angle glaucoma (POAG) patients showed signs of severe glaucoma, including severe optic disc cupping ($P = 0.019$) and visual field defects ($P = 0.014$). Hearing defects were the only significantly associated non-ocular feature

*Corresponding author.

How to cite this paper: Onochie, C., Okoye, O., Onakoya, A., Ogunro, A., Hassan, K., Ihemedu, C., Aribaba, T. and Okonkwo, O. (2016) Prevalence and Associations of Pseudoexfoliation Glaucoma in a Group of Tertiary Eye Care Facilities in Southwest Nigeria. *Open Journal of Ophthalmology*, **6**, 70-79. http://dx.doi.org/10.4236/ojoph.2016.62010

(*P* = 0.0005). Conclusion: The prevalence of PXG was 16.9%. This implies that it is relatively common in Nigeria. Hearing loss is an important non-ocular association. Careful ocular examination of glaucoma patients is recommended to identify PXG, which runs a more severe clinical course than POAG.

Keywords

Prevalence, Pseudoexfoliation Glaucoma, Pseudoexfoliation Syndrome, Nigeria

1. Introduction

Glaucoma is the second leading cause of blindness and the leading cause of irreversible blindness worldwide [1]. It accounts for 12.3% of the 37 million cases of blindness globally [2] and is characterized by optic neuropathy, a typical visual field defect for which elevated intraocular pressure (IOP) is a risk factor [3]. Glaucoma may be congenital or acquired. Sub-classification into open-angle and angle-closure types is premised on the mechanism by which aqueous outflow is impaired in relation to anterior chamber angle anatomy. A distinction is also made between primary and secondary glaucoma; in the latter, an identifiable ocular or nonocular disorder contributes to elevation of IOP [4]. The higher IOP observed in PXG can lead to more rapid optic nerve damage, visual field loss and increased risk of blindness [5]. Primary open-angle glaucoma (POAG) is the most common form of adult glaucoma, while pseudoexfoliation glaucoma (PXG), characterized by the presence of pseudoexfoliative material, is the most common identifiable form of secondary open-angle glaucoma worldwide. PXG occurs as a complication of pseudoexfoliation syndrome (PXS) [6] [7]. PXS is an age-related, generalized disorder of the extracellular matrix, first described in 1917 by Finnish ophthalmologist John Lindberg [8]. The syndrome is characterized by flakes of granular material throughout the inner surface of the anterior chamber [9]. PXS is a known risk factor for developing cataract [10]. Complicating factors such as poor mydriasis and zonular weakness have all been reported after cataract surgery [11] [12]. PXS is considered to be a systemic disorder [13]. An association between PXS and sensorineural deafness has also been reported [14] [15].

The prevalence of PXS in Nigerian communities has been reported to be very low [16]. However; several investigators have reported high proportions of PXG among patients with PXS, ranging from 30.3% [17] to 67% [16].

The prevalence of PXG among glaucoma patients varies in different communities. A study in United States reported PXG among glaucoma patients to be 19% [18]. In South India, PXG was found in 4.2% of glaucoma patients [19]. In Western India, prevalence of PXG increased with increasing age, reaching 30% in the population aged 60 years and older [20]. A survey in Pakistan showed that out of 3195 patients, 58 (1.81%) had pseudoexfoliation syndrome, out of which 21 patients showed PXG [21]. In Nigeria; the prevalence of PXG among open-angle glaucoma patients was 3.6% [16].

Poor clinical search for the disease and dearth of published data may have been responsible in part for the assumed low prevalence in Nigeria and West African communities. The first study regarding pseudoexfoliation syndrome in Nigeria, published by Olawoye *et al.* [16] in 2012, reported its prevalence in an eye clinic in Ibadan, Nigeria. This present study determined the prevalence of pseudoexfoliation glaucoma and its characteristics in the glaucoma clinics of three tertiary eye hospitals in southwestern Nigeria. As well as adding to the fledgling literature, it is hoped that the findings will contribute to informed intervention to fill the gap in treatment for this subtype of primary open glaucoma among practicing ophthalmologists.

2. Materials and Methods

2.1. Background

The study was conducted at three tertiary eye care facilities: Eye Foundation Hospital (EFH) in Ikeja, Lagos, Guinness Eye Center (GEC) at the Lagos University Teaching Hospital (LUTH) in Idi-Araba, Lagos, and Deseret Community Vision Institute (DCVI) in Ijebu-Imushin, Ogun State. The three centers are located in two of the six states of the southwest geopolitical zone of Nigeria, and all are equipped to provide basic and specialist medical, optical, laser and surgical eye care services to the population of the two states and environs. Average

annual hospital admissions are 1055, 240 and 555 for EFH, LUTH and DCVI respectively. These centers are major referral centers, board certified for residency and various subspecialty training in ophthalmic postgraduate education.

2.2. Study Design

This was a multi-center, descriptive, cross-sectional study conducted among newly diagnosed glaucoma patients at EFH, DCVI and GEC between October 2012 and October 2013.

2.3. Sample Size Determination

The sample size was estimated to be 139 using the Zar formula [22] for descriptive cross sectional studies after making allowance for attrition, non-responders and incomplete data.

2.4. Study Eligibility

Consenting patients aged over 40 years with newly diagnosed OAG were included in the study, while patients with ocular hypertension as well as those who refused participation were excluded from the study.

2.5. Ethics

Ethics approval consistent with the tenets of the 1964 Declaration of Helsinki was obtained from Ethics and Research Committee of LUTH (ADM/DCST/HREC/Vol. XVI/APP/765).

2.6. Study Procedure

The study comprised two stages. Stage 1 was the establishment of the diagnosis of glaucoma. Distance visual acuity was tested using a Snellen chart or tumbling E chart placed 6 meters from the participant. Visual acuity was classified based on the WHO classification of visual impairment and blindness [23]. Under this classification, vision is classified as normal vision, moderate visual impairment, severe visual impairment and blindness.

A pen light was used to assess pupillary response. The iris was examined with a slit lamp biomicroscope. The intraocular pressure (IOP) was measured using a slit lamp biomicroscope with an attached Haag-Streit Goldmann applanation tonometer. Central corneal thickness measurement was done using the Alcon Ocuscan RxP ultrasonic pachymeter, S/N 100246010IX. Herndon's formula was utilized for the calculation of true IOP [24]. The pupil was dilated using 1% tropicamide. The posterior segment was examined using a +78D Volk lens indirect slit lamp biomicroscope.

Ocular perimetry was done to confirm glaucoma in those with suspicious discs using the central visual field (CVF) perimeter (Zeiss Humphrey Matrix FDT). A reliable result was expected to have fixation losses < 20%, false negatives < 33% and false positive < 33%. The mean deviation of the most reliable CVF was coded and recorded. Only eyes with visual acuity > 3/60 were suitable for CVF. Those with IOP > 21 mmHg, with other features suggestive of glaucoma, were regarded as high tension glaucoma patients. However, those with IOP > 21 mmHg without features suggestive of glaucoma were regarded as ocular hypertensive patients and were excluded from the study.

In Stage 2, following diagnosis of glaucoma, patients were given an appointment within one week for examination of the eye for pseudoexfoliation and subsequent treatment. The patients to enter Stage 2 were selected by simple random sampling through balloting. The study proforma was used to obtain bio-demographic information, relevant medical and social history. All patients underwent a fasting blood sugar measurement (FBS) and 2-hour postprandial test (2 HPP), done using a glucometer. Those with fasting blood sugar (FBS) > 7.1 mmol/L and 2 HPP > 11.1 mmol/L, with or without history of diabetes, were classified as having diabetes mellitus. Blood pressure measurement was done using a mercury sphygmomanometer. Systemic hypertension was considered in patients with two consecutive systemic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 85 mmHg [25].

A history of significant alcohol intake was defined, based on recommendations from NHS Scotland, as ingestion of more than 21 units of alcohol per week for men and more than 14 units per week for women [26]. A positive history of smoking was defined as having smoked 1 pack-year or more for five years. One pack-year means

smoking 20 cigarettes a day, every day for 1 year [27].

Self-reported history of hearing loss was also documented. However, types of hearing loss were not distinguished.

These steps were followed by a careful anterior segment slit lamp examination for pseudoexfoliative material on anterior segment structures. Gonioscopy was done using a three-mirror gonio lens to determine open or closed angle of the anterior chamber, presence of dandruff-like materials in the trabecular meshwork, and assessment of Sampaolesi's line and trabecular pigmentation.

2.7. Definition of Terms

The following terminologies and classifications were used in the study.

Pseudoexfoliation syndrome (PXS): This was defined by the presence of pseudoexfoliative material (PXM) at the pupil border on undilated examination, or anterior lens capsule on dilated examination, or by the trabecular meshwork on gonioscopy, with or without Sampaolesi's line and pigment deposition in the angle [8].

Pseudoexfoliation glaucoma (PXG): This was defined by the presence of glaucoma as defined above with PXS [6].

Pupil dilation: A good pupil dilation was noted when pupil size was > 5 mm at least 30 minutes following the application of a short-acting mydriatic agent, and poor if pupil size was 5 mm or less.

Severity of glaucoma: This was determined by the cup-disc ratio (CDR) and CVF. CDR of 0.5 - 0.6 was considered mild damage, 0.6 - 0.8 was considered moderate damage, and greater than 0.8 was considered severe damage.

The severity of glaucoma was classified based on the gray scale and mean deviation using the Hodapp- Parrish-Anderson criteria for staging glaucoma [28]. Accordingly in the grey scale, no visual field changes are taken as normal, generalized depression/Siedel scotoma as mild defect, semi-arcuate-bi-arcuate/ring scotoma as moderate defect and tunnel-complete loss as severe defect. On the mean deviation, −0.01 to −6.00 dB is regarded as early defect, −6.01 to −12.00 dB as moderate defects, −12.01 to −20.00 dB as advanced defect and >−20 dB or worse as severe defect.

2.8. Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS), version 16 (SPSS Inc), and reported as frequency distributions, percentages and means ± standard deviation (SD). Statistical testing for significance of observed intergroup differences were performed using the chi-square test for categorical variables and Student's t-test for continuous variables. In all comparisons, $P < 0.05$ was considered to be statistically significant (confidence level = 95%).

3. Results

One hundred and forty adult glaucoma patients were recruited for the study. The age range was between 40 and 89 years with mean age of 60.5 ± 11.9 SD. There were 93 (66.4%) males and 47 (33.6) females (M:F, 2:1). Patients were predominantly Yorubas 76 (54.3%). Sociodemographic information is shown in **Table 1**.

Thirty four patients (24.2%) reported a significant history of alcohol intake, and 7 (5%) were regular smokers. The social and medical history of the study patients is presented in **Table 2**.

The age-adjusted prevalence rate of PXG among newly diagnosed POAG patients was 16.9% as calculated by indirect standardization. PXM was seen on the pupil (39%), on the iris (34%), anterior capsule (20%), anterior chamber (5%), and on the corneal endothelium (2%).

The ages of PXG patients were between 45 and 82 years with mean age of 60.8 ± 9.3 years and modal age of 50 - 59. A higher proportion of PXG patients were males compared to females, with a ratio of 1.6:1.

Out of the 25 patients with PXG, 19 (76%) were found to have bilateral PXG and the remaining 6 (24%) had unilateral PXG, four in the right eye and two in the left eye.

Ocular features seen among the PXG patients are shown in **Table 3**. Pupil size was found to be 5 mm or less 30 minutes after application of topical tropicamide in 44% of PXG patients (OR 0.615, $P = 0.0001$, CI 0.454 - 0.834).

A higher proportion of PXG patients, 20; 80%), had cataracts when compared with the POAG group, 72 (69.2%) ($\chi^2 = 0.612$, OR = 2.34, $P = 0.367$, CI = 0.81 - 6.75).

The vertical cup-disc ratio was compared in PXG and POAG patients, as shown in **Table 4**. The missing data were unable to be obtained from patients whose fundi could not be viewed.

There was no statistically significant difference between the mean IOP values of patients with PXG and POAG in either eye (PXG vs POAG: right eye 18.7 ± 8.0, left eye 20.0 ± 10.2, $P = 0.875$ vs right eye 19.1 ± 9.6, left eye 18.5 ± 0.443, $P = 0.443$).

The extent of visual field damage in PXG patients was found to be severe compared to POAG patients, and

Table 1. Socio-demographic distribution of study patients.

Variables	Frequency	Percentage (%)
Age group (years)		
40 - 49	29	20.1
50 - 59	42	30.2
60 - 69	30	21.6
70 - 79	31	22.3
80 - 89	8	5.8
Total	**140**	**100.0**
Sex		
Male	93	66.4
Female	47	33.6
Total	**140**	**100.0**
Tribal distribution		
Yoruba	76	54.3
Ibo	31	22.1
Edo/Delta	16	11.4
Hausa/Fulani	12	8.6
Others	5	3.5
Total	**140**	**100.0**
Religion		
Christianity	112	80.0
Islam	25	17.9
Others	3	2.1
Total	**140**	**100.0**
Occupational status		
Retired	40	28.8
Self employed	32	23.0
Professional	26	18.6
Civil servant	22	15.1
Artisan	15	10.7
Farmer	4	2.9
Unemployed	1	0.7
Total	**140**	**100.0**
Educational status		
None	2	1.4
Primary	5	3.6
Secondary	3	25.7
Tertiary	97	69.3
Total	**140**	**100.0**

Table 2. Social and medical history of the study patients.

Variables	**Positive**	**Negative**
	Frequency (%)	
Alcohol	34 (24.2)	106 (75.8)
Smoking	7 (5)	133 (95.0)
Systemic hypertension	68 (48.6)	72 (51.4)
Diabetes mellitus	28 (20.0)	112 (80.0)
Hearing defect	17 (12.1)	123 (87.9)

this was in tandem with the optic disc damage (PXG vs POAG: 47.8% vs 21.3%, $P = 0.015$).

Patients aged between 50 and 59 accounted for most of the PXG 8 (32%) and POAG 28 (26.8%) cases. **Table 5** shows the age distributions of PXG and POAG patients. A higher proportion of males accounted for onset of PXG 15 (60%) and POAG 71 (68.3%) though not statistically significant, **Table 6**.

Table 3. Ocular features peculiar to PXG eyes among study patients.

Ocular features	Frequency	Percentage
Corneal		
Epithelial defects	6	13.6
Endothelial defects	2	4.6
Iris		
Iridodonesis	3	6.8
Transillumination	3	6.8
Anterior chamber angle		
Sampaolesi's line	18	41.0
Pigmentation	12	27.2
Total	**44**	**100**

Table 4. Optic disc damage in PXG and POAG patients.

CDR	RIGHT EYE		LEFT EYE	
	PXG	POAG	PXG	POAG
	Frequency (%)		Frequency (%)	
<0.4	4 (16)	2 (2)	3 (12)	2 (2)
0.5 - 0.6	4 (16)	17 (17)	2 (8)	14 (14)
0.65 - 0.8	3 (12)	32 (31)	7 (28)	43 (44)
0.85 - 1.0	12 (48)	41 (38)	12 (48)	38 (37)
Missing	2 (8)	12 (12)	1 (4)	3 (3)
Total	**25 (100)**	**104 (100)**	**25 (100)**	**104 (100)**
p-value	0.019		0.145	

Table 5. Age distribution of PXG and POAG patients.

Age range	PXG frequency (%)	POAG
40 - 49	5 (20)	19 (18.3)
50 - 59	8 (32)	28 (26.8)
60 - 69	5 (20)	24 (23.0)
70 - 79	5 (20)	22 (21.2)
80 - 89	2 (8)	11 (10.7)
Total	25 (100)	104 (100)

$\chi^2 = 45.841$, df = 1, $P = 0.0001$.

Table 6. Effect of gender on the onset of PXG.

Variables	GENDER Frequency (%)			p-value
	Male	Female	Total	
PXG	15 (60.0)	10 (40.0)	25 (19.3)	0.363
POAG	71 (68.3)	33 (31.7)	104 (80.7)	
Total	**86 (66.7)**	**43 (33.3)**	**129 (100)***	

Chi square test = 1.715 Odd Ratio = 0.783, 95% CI of OR (0.33 - 1.84).
Key * Only 129 patients among the total 140 patients were compared that is 25 patients with PXG and 104 patients with POAG. The other patients were excluded from the comparison.

Patients a with positive history of cigarette smoking were significantly more common in the PXG group 5 (17%) (P = 0.002, OR 21.04, CI 2.23 - 188.52).

A higher proportion of patients in the PXG group, 15 (60%), were found to have systemic hypertension, as compared with the POAG group (46.1%). For diabetes mellitus, the proportions of patients with the condition in the PXG and POAG groups were 24% and 17%, respectively. However, these differences were not statistically significant (P = 0.187 for systemic hypertension; P = 0.291 for diabetes mellitus).

4. Discussion

The mean age of the glaucoma patients in this study was similar to the mean age of 58.13 ± 13.8 observed in a similar study of Nigerian patients by Olawoye *et al.* [16], and 67.4 ± 2 observed in a South African study by Mdlankomo [29]. The modal age of the patients was in the 50 - 59 years age group for both PXG and POAG. This is reflective of the age specific study population of these studies.

There were more men than women with PXG in this study. This is similar to findings in surveys by Olawoye *et al.* and Mdlankomo [16] [29]. This may be accounted for by the larger proportion of male participants in the surveys. There was a predominance of the Yoruba tribe in the study population, and this was similar to findings in the study by Olawoye *et al.* [15]. This study was carried out in the southwestern part of Nigeria, which is predominantly populated by the Yoruba ethnic group.

The prevalence rate of PXG among glaucoma patients in this study was in agreement with studies by Stephen *et al.* [30] and Rotchford *et al.* [31], which found the prevalence of PXG among glaucoma patients to be 16.4% and 25%, respectively. Olawoye *et al.* and Thomas *et al.* found much lower PXG prevalence, 3.5% and 4.2% respectively [16] [19]. This disparity may have been due to the larger sample size used in these studies.

The laterality of PXG observed in this study was similar to the findings by Yeshigeta *et al.* [32], which noted a bilateral occurrence of 66.7% and unilateral occurrence of 33.7%. This observation also concurred with other similar studies [33]-[38]. This is expected since the disease process is usually bilateral, as elucidated by Prince *et al.* [39].

Pseudoexfoliative materials (PXM) were predominantly seen on the pupil, anterior iris and anterior lens capsule in decreasing frequency in PXG patients. The finding of 39% of PXM on the pupillary margin was in conformity with studies by Ghosh *et al.* that documented pseudoexfoliates to be found on the pupillary margin in 32% - 94% of PXS cases [40].

Poor pupillary dilation was observed in PXG patients and was clinically significant (P = 0.0001). This was in agreement with other studies showing eyes with PXS to have significantly more poorly dilating pupils compared to those with POAG and diabetes [5] [37]. This is as a result of infiltration of iris stroma with excessive extracellular matrix, causing mechanical obstruction of the dilator muscles during mydriasis [41]. Furthermore, histological studies have shown the presence of fibrotic disorganized or degenerative muscle tissue in most PXS and PXG specimens and not in controls [5] [42]. Poor dilation also may be partly due to subclinical posterior synechiae from the PXM forming an apposition to the posterior iris.

There was no statistically significant difference in IOP between the PXG and POAG groups. Although in a few cases PXG patients had higher IOP, these findings may be due to chance. This finding was in contrast to previously published results, in which PXG patients have shown higher IOPs than POAG patients [43] [44]. The reason for this difference may be due to a relatively smaller sample population used in this study, or perhaps in our environment, IOP in PXG patients may be similar to that in POAG patients. However, Olawoye *et al.* in their study in a Nigerian environment noted a higher IOP amongst patients with PXS than in those without [16]. Hence, further studies on the IOP comparison between these two groups of glaucoma patients are necessary in Nigeria to establish the pattern of differences in IOP between these groups of patients.

A higher proportion of optic disc cupping was observed among PXG patients in comparison to POAG patients, and this was clinically significant (P = 0.019). This finding agrees with other studies confirming that glaucoma in PXS has a more serious clinical course and worse prognosis than POAG [5] [45]. Another study showed eyes with unilateral PXS having unilateral optic disc changes in the eyes with PXS, even though equal IOP was observed in both eyes of the pairs [46]. This suggests that the exfoliative process itself may be a risk factor for optic disc changes.

Visual field damage seen in PXG patients was found to be more severe than in POAG patients and this was clinically significant (P = 0.014 in the right eye and P = 0.025 in the left eye). This is also in agreement with the other studies that show PXG patients to have a significantly higher frequency and severity of visual field dam-

age than POAG patients [5] [47]. The implication for practice is that eye care providers will need to search for this subtype of glaucoma while evaluating glaucoma patients in order to institute appropriate treatment to combat the more aggressive nature of this disease.

In this study, there was a statistically significant relationship (P = 0.0005) between hearing loss and PXG. Shazly *et al.* noted a clinically significant hearing loss in 8.1% of PXS patients [17]. The comparatively high frequency noted in this study may be due to differences in the study populations. In addition, history of hearing loss in this study was self-reported. No objective evaluation of hearing loss was done. Shazly *et al*'s survey was among PXS and not PXG patients. Cahill *et al.* reported that a large proportion of patients with PXS have sensorineural hearing loss in comparison to age matched controls, regardless of whether or not there is associated glaucoma [48]. Furthermore, Turgut *et al.* in a recent study reported a high prevalence of asymptomatic vestibular dysfunction among patients with PXS [49].

Previous studies have shown PXS and PXG to be associated with increasing age [5] [50]. This pattern was not seen in this study, which found no significant difference in the ages of patients with PXG vs POAG. Other possible risk factors that were assessed in this study included gender, effect of alcohol, systemic hypertension and type 2 diabetes mellitus, all of which showed higher proportions in PXG patients but these findings were not statistically significant.

Limitations of the Study

Extrapolation of findings from this study is limited by its hospital-based nature. The inter-observer variations of cup-disc ratio are also a limitation of findings in this study. In addition, the diagnosis of pseudoexfoliation glaucoma was strictly on clinical evaluation without a polymerase chain reaction to identify the lysyl-oxidase-like-1 (LOXL1) gene. This method has the potential to result in false positives, exaggerating the estimated prevalence. Hearing loss was only self-reported and there was no objective measurement of the type of hearing loss carried out in the study. This could have misrepresented its frequency in the PXG population.

5. Conclusion

The prevalence of pseudoexfoliation glaucoma is relatively higher than what was previously reported among glaucoma patients within our environment. Significant association with PXG was found for poor pupillary dilatation, severe clinical course and hearing loss. A population-based study is suggested to further define the prevalence and characteristics of PXG and PXS in this region. Eye care practitioners should make a careful search for this subtype of open angle glaucoma because of its more severe clinical course, in order to enhance effective treatment and prevention of blindness.

Conflict of Interests

None of the authors have any proprietary interests or conflicts of interest related to this submission.

This submission has not been published anywhere previously and it is not simultaneously being considered for any other publication.

References

[1] Reskinoff, S., Pascolini, D., Etya'ale, D., Kocur, I., Pararajasegaram, R., Pokharel, G.P. and Mariotti, S.P. (2004) Global Data on Visual Impairment in the Year 2002. *Bulletin of the World Health Organization*, **82**, 844-851.

[2] Giangiacomo, A. and Coleman, A.L. (2009) The Epidemiology of Glaucoma. In: Grehn, F. and Stamper, R., Eds., Glaucoma, Springer, Berlin. http://dx.doi.org/10.1007/978-3-540-69475-5_2

[3] Lindbloom, B. and Thorburn, W. (1984) Observed Incidence of Glaucoma in Halsingland, Sweden. *Acta Ophthalmologica*, **60**, 217-222. http://dx.doi.org/10.1111/j.1755-3768.1984.tb08397.x

[4] Hiller, R., Sperduto, R.D. and Krueger, D.E. (1982) Pseudoexfoliation, Intraocular Pressure and Senile Lens Changes in a Population-Based Survey. *Archive of Ophthalmology*, **100**, 1080-1084. http://dx.doi.org/10.1001/archopht.1982.01030040058007

[5] Ritch, R. and Schlotzer-Schrehardt, U. (2001) Exfoliation Syndrome. *Survey of Ophthalmology*, **45**, 103-110. http://dx.doi.org/10.1016/S0039-6257(00)00196-X

[6] Majka, C.P. and Challa, P. (2006) Ophthalmic Pearls. Glaucoma—Diagnosis and Management of Pseudoexfoliation

Glaucoma. The Eye Net Magazine.
www.aao.org/eyenet/article/diagnosis-management-of-pseudoexfoliation-glaucoma?june-2006

[7] Ritch, R. (1994) Exfoliation Syndrome. The Most Common Identifiable Cause of Open-Angle Glaucoma. *Journal of Glaucoma*, **3**, 176-177. http://dx.doi.org/10.1097/00061198-199400320-00018

[8] Tarkkanen, A., Kivelä, T. and Lindberg, J.G. (2002) The Discovery of Exfoliation Syndrome. *Acta Ophthalmologica*, **80**, 151-154. http://dx.doi.org/10.1034/j.1600-0420.2002.800206.x

[9] Roth, M. and Epstein, D.L. (1980) Exfoliation Syndrome. *American Journal of Ophthalmology*, **89**, 477-481. http://dx.doi.org/10.1016/0002-9394(80)90054-9

[10] Hirvela, H., Luukinen, H. and Laatikainen, L. (1995) Prevalence and Risk Factors of Lens Opacities in the Elderly in Finland. *Ophthalmology*, **102**, 108-117. http://dx.doi.org/10.1016/S0161-6420(95)31072-X

[11] Alfaite, M., Leite, E., Mira, J. and Cunha-Vaz, J.G. (1996) Prevalence and Surgical Complications of Pseudoexfoliation Syndrome in Portuguese Patients with Senile Cataract. *Journal of Cataract and Refractive Surgery*, **22**, 972-976. http://dx.doi.org/10.1016/S0886-3350(96)80202-1

[12] Lumme, P. and Laatikainen, L. (1993) Exfoliation Syndrome and Cataract Extraction. *American Journal of Ophthalmology*, **116**, 51-55. http://dx.doi.org/10.1016/S0002-9394(14)71743-X

[13] Schlotzer-Schrehardt, U.M., Koca, M.R., Naumann, G.O. and Volkholz, H. (1992) Pseudoexfoliation Syndrome. Ocular Manifestation of a Systemic Disorder? *Archives of Ophthalmology*, **110**, 1752-1756. http://dx.doi.org/10.1001/archopht.1992.01080240092038

[14] Balatsouras, D., Detorakis, E.T., Kozobolis, V.P., Paliobei, V., Kefalidis, G., Konstas, A.G.P., Daniilidis, V. and Chrysochoou, F. (2008) Evaluation of the Acoustic Function in Pseudoexfoliation Syndrome and Exfoliation Glaucoma: Audiometric and Tympanometric Findings. *European Journal of Ophthalmology*, **18**, 71-76.

[15] Yazdani, S., Tousi, A., Pakravan, M. and Faghihi, A.R. (2008) Sensorineural Hearing Loss in Pseudoexfoliation Syndrome. *Ophthalmology*, **115**, 425-429. http://dx.doi.org/10.1016/j.ophtha.2007.10.038

[16] Olawoye, O.O., Ashaye, A.O., Teng, C.C., Liebmann, J.M., Ritch, R. and Ajayi, B.G. (2012) Exfoliation Syndrome in Nigeria. *Middle East African Journal of Ophthalmology*, **19**, 402-405. http://dx.doi.org/10.4103/0974-9233.102759

[17] Shazly, T.A., Farrag, A.N., Kamel, A. and Al-Hussaini, A.K. (2011) Prevalence of Pseudoexfoliation Syndrome and PXG in Upper Egypt. *BMC Ophthalmology*, **11**, 18. http://dx.doi.org/10.1186/1471-2415-11-18

[18] Cashwell Jr., L.F. and Shields, M.B. (1988) Exfoliation Syndrome in the Southeastern United States. I. Prevalence in Open-Angle Glaucoma and Non-Glaucoma Populations. *Acta Ophthalmologica*, **66**, 99-102. http://dx.doi.org/10.1111/j.1755-3768.1988.tb02637.x

[19] Thomas, R., Nirmalan, P. and Krishnaiah, S. (2005) Pseudoexfoliation in Southern India: The Andhra Pradesh Eye Disease Study. *Investigative Ophthalmology & Visual Science*, **46**, 1170-1176. http://dx.doi.org/10.1167/iovs.04-1062

[20] Rao, V., Doctor, M. and Rao, G. (2015) Prevalence and Prognosis of Pseudoexfoliation Glaucoma in Western India. *Asia-Pacific Journal of Ophthalmology*, **4**, 121-127. http://dx.doi.org/10.1097/APO.0b013e3182a0af43

[21] Shafiq, I. and Sharf-ul-Hasan, K. (2007) Pseudoexfoliation (PEX) Glaucoma over the Age of 40 Years; A Hospital Based Study. *Pakistan Journal of Ophthalmology*, **23**, 221-227.

[22] Zar, J.H. (1998) Biostatistics Analysis. 4th Edition, Prentice Hall, Upper Saddle River.

[23] World Health Organization (2013) Visual Impairment and Blindness. www.who.int/mediacentre/factsheets/fs282/en/

[24] Herndon, L.W. (2006) Measuring Intraocular Pressure-Adjustments for Corneal Thickness and New Technologies. *Current Opinion in Ophthalmology*, **17**, 115-119. http://dx.doi.org/10.1097/01.icu.0000193093.05927.a1

[25] National High Blood Pressure Education Program (2004) The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure. No. 04-5230, NIH Publication.

[26] NHS Inform. Alcohol Misuse, Health Library.
http://www.nhsinform.com/health-library/articles/a/alcohol-misuse/introduction

[27] Francisca Medical Specialists. Calculating Your Smoking History.
http://www.medspecindiana.com/healthcare/calculating-your-smoking-history

[28] Remo, S. and Vessani, R.M. (2009) Staging the Glaucoma Patient: Why and How? *The Open Ophthalmology Journal*, **3**, 59-64. http://dx.doi.org/10.2174/1874364100903010059

[29] Mdlankomo, R. (2012) Pseudoexfoliation Syndrome in a Rural Glaucoma Clinic in the Eastern Cape, South Africa. University of the Witwatersrand, Johannesburg. http://hdl.handle.net/10539/12282

[30] Stephen, B. (1999) Pseudoexfoliation Glaucoma in Sri Lanka. *The Ceylon Journal of Medical Science*, **42**, 19-25.

[31] Rotchford, A.P., Kirwan, J.F., Johnson, G.J. and Roux, P. (2003) Exfoliation Syndrome in Black South Africans. *Archives of Ophthalmology*, **121**, 863-870. http://dx.doi.org/10.1001/archopht.121.6.863

[32] Yeshigeta, G. and Yemariamwork, T. (2012) Clinical Characteristics of Cataract Patients with Pseudoexfoliation Syndrome at Jimma University Specialist Hospital, South West Ethiopia. *Ethiopian Journal of Health Science*, **22**, 1-6.

[33] Tliksew, T. and Kefyalew, R. (2004) Prevalence of Pseudoexfoliation Syndrome in Ethiopian Patients Scheduled for Cataract Surgery. *Acta Ophthalmologica Scandinavica*, **82**, 285-287

[34] Robert, R. (1996) The Glaucoma, Clinical Science. 2nd Edition, Ann Patterson, New York.

[35] Taurone, S., Ripandelli, G., Pacella, E., Bianchi, E., Plateroti, A.M. and De Vito, S. (2015) Potential Regulatory Molecules in the Human Trabecular Meshwork of Patients with Glaucoma: Immunohistochemical Profile of a Number of Inflammatory Cytokines. *Molecular Medicine Reports*, **11**, 1384-1390.

[36] Cavallotti, C., Artico, M., Pescosolido, N., Tranquilli Leali, F.M. and Pacella, E. (2000) Distribution of Peptidergic Nerve Fibres in the Guinea Pig Trabecular Meshwork. *Anatomia, Histologia, Embryologia*, **29**, 387-391. http://dx.doi.org/10.1046/j.1439-0264.2000.00290.x

[37] Pacella, E., Pacella, F., Cavallotti, C., Librando, A., Feher, J. and Pecori-Giraldi, J. (2010) The Combination Latanoprost-Timolol versus Twice Daily 0.50% Timolol Administration either Associated or Not with Latanoprost: Efficacy and Tolerability in the Primary Open-Angle Glaucoma. *European Review for Medical and Pharmacological Sciences*, **14**, 477-480.

[38] Pacella, F., Turchetti, P., Santamaria, V., Impallara, D., Smaldone, G., *et al*. (2012) Differential Activity and Clinical Utility of Latanoprost in Glaucoma and Ocular Hypertension. *Clinical Ophthalmology* (*Auckland, N.Z.*), **6**, 811-815. http://dx.doi.org/10.2147/OPTH.S13777

[39] Prince, A.M., Streeten, B.W., Ritch, R., Dark, A.J and Sperling, M. (1987) Preclinical Diagnosis of Pseudoexfoliation Syndrome. *Archives of Ophthalmology*, **105**, 1076-1082. http://dx.doi.org/10.1001/archopht.1987.01060080078032

[40] Ghosh, M. and Speakman, J.S. (1974) The Iris in Senile Exfoliation of the Lens. *Canadian Journal of Ophthalmology*, **9**, 289-297.

[41] Watson, N., Winder, S. and Green, F. (1995) Pupil Dilatation in the Pseudoexfoliation Syndrome. *Eye*, **9**, 341-343. http://dx.doi.org/10.1038/eye.1995.66

[42] Cavallotti, C., Pescosolido, N., Artico, M., Pacella, E. and Cavallotti, D. (2001) Occurrence of Catecholaminergic Nerve Fibers in the Human Uveoscleral Tissue in Conditions of Normal and Raised Intraocular Pressure. *International Ophthalmology*, **24**, 133-139. http://dx.doi.org/10.1023/A:1021173115883

[43] Aasved, H. (1971) Intraocular Pressure in Eyes with and without Fibrillopathia Epitheliocapsularis (So-Called Senile Exfoliation or Pseudoexfoliation). *Acta Ophthalmologica*, **49**, 601-610. http://dx.doi.org/10.1111/j.1755-3768.1971.tb02967.x

[44] Konstas, A.G., Stewart, W.C. and Stroman, G.A. (1997) Clinical Presentation and Initial Treatment Patterns in Patients with Exfoliation Glaucoma versus Primary Open-Angle Glaucoma. *Ophthalmic Surgeries and Lasers*, **28**, 111-117.

[45] Konstas, A.G., Tsatsos, I., Kardasopoulos, A., Bufidis, T. and Maskaleris, G. (1998) Preoperative Features of Patients with Exfoliation Glaucoma and Primary Open-Angle Glaucoma. The AHEPA Study. *Acta Ophthalmologica*, **76**, 208-212. http://dx.doi.org/10.1034/j.1600-0420.1998.760217.x

[46] Puska, P., Vesti, E. and Tomita, G. (1999) Optic Disc Changes in Normotensive Persons with Unilateral Exfoliation Syndrome. A 3-Year Follow-Up Study. *Graefe's Archive for Clinical and Experimental Ophthalmology*, **237**, 457-462. http://dx.doi.org/10.1007/s004170050261

[47] Lindblom, B. and Thorburn, W. (1982) Prevalence of Visual Field Defects Due to Capsular and Simple Glaucoma in Halsingland, Sweden. *Acta Ophthalmologica*, **60**, 353-361. http://dx.doi.org/10.1111/j.1755-3768.1982.tb03025.x

[48] Cahill, M., Early, A., Stack, S., Blayney, A.W. and Eustace, P. (2002) Pseudoexfoliation and Sensorineural Hearing Loss. *Eye*, **16**, 261-266. http://dx.doi.org/10.1038/sj.eye.6700011

[49] Turgut, B., Alpay, H.C., Kaya, M.K., Oger, M., Celiker, U. and Yalcin, S. (2010) The Evaluation of Vestibular Function in Patients with Pseudoexfoliation Syndrome. *European Archives of Oto-Rhino-Larygology*, **267**, 523-527. http://dx.doi.org/10.1007/s00405-009-1093-6

[50] Forsius, H. (1988) Exfoliation Syndrome in Various Ethnic Populations. *Acta Ophthalmologica*, **66**, 71-85. http://dx.doi.org/10.1111/j.1755-3768.1988.tb02633.x