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Correlation between Primary Open-Angle Glaucoma and Symptoms of Obstructive Sleep Apnea Syndrome: A Case-Control Study Conducted in Abidjan

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Abstract

Introduction: Primary open-angle glaucoma (POAG) is a chronic progressive optic neuropathy which is a major cause of irreversible blindness worldwide. Its pathogenesis, which is still poorly understood, involves intrinsic and extrinsic factors. Most of the treatment is based on intraocular pressure, which is the main modifiable factor. Among extraocular factors, obstructive sleep apnea syndrome (OSAS) is rarely investigated in practice by ophthalmologists. Also, few studies in sub-Saharan Africa have explored the relationship between POAG and OSAS in African populations, hence the interest of this work, which aims to establish the correlation between POAG and OSAS symptoms. Patients and Method: The authors conducted a prospective cross-sectional case-control study at the Treichville University Hospital in Abidjan over a twelve-month period from January 2022 to December 2023 in a population of melanoderms adults subdivided into two subgroups, one for glaucoma patients and the other for non-glaucomatous patients, in search of signs of OSAS. Signs of OSAS were sought in all patients regardless of subgroup. Patient records were selected after written informed consent. Incomplete records and patients with defects were not included. The study took into account ethical and deontological considerations in accordance with the principles of the declaration of Helsinki. The data collected were epidemiological, anamnestic and clinical (signs of OSAS). They were collected on a survey form and analysed using Microsoft 2016 and Epi Info 7 version 1.3 software. The statistical significance threshold was $\alpha < 5\%$. Results: We collected 159 patients divided into two subpopulations, predominantly male (57.23%). The predominant age group was between 40 and 50 years. Clinically, snoring predominated in glaucoma patients (63.29%) com-

pared with (36.25%) in non-glaucoma patients (p = 0.001). On the Epworth scale, excessive daytime sleepiness was more frequent in glaucoma patients than in the control population, 73.68% versus 26.32% (p = 0.001). According to the ODSI questionnaire, daytime sleepiness was higher in glaucoma patients than in non-glaucoma patients 72.22% versus 27.78% (p = 0.003). Discussion: This study revealed a higher prevalence of OSAS symptoms in patients with POAG. Signs such as snoring and daytime sleepiness were identified as being significantly associated with both pathologies. Thus, having a symptom of sleep apnea increases the risk of developing chronic glaucoma in the African melanoderm population. In addition to lowering intraocular pressure, it is important to stress the importance of screening and managing sleep apnea symptoms in all glaucoma patients.

Subject Areas

Ophthalmology

Keywords

Primary Open-Angle Glaucoma, Optic Neuropathy, Risk Factor, Obstructive Sleep Apnea Syndrome, Snoring, Daytime Sleepiness

1. Introduction

Primary open-angle glaucoma (POAG) is a chronic, progressive, bilateral optic neuropathy that is most often asymmetrical and combines abnormalities of the optic nerve head with visual field deterioration and non-obligatory ocular hypertension in an open iridocorneal angle [1]. Its pathogenesis remains poorly understood, and ocular hypertension remains the modifiable risk factor on which the entire therapeutic strategy is based. Among other extraocular risk factors, obstructive sleep apnea syndrome (OSAS) is well known in the literature [2]. The association between POAG and OSAS was first described by Walsh and Monplaisir [3]. However, this association is rarely investigated in routine practice. Black African glaucoma is characterised by being more severe and occurring at an earlier age, and its management should require adequate control of the associated risk factors. Given the scarcity of local studies in sub-Saharan Africa, we initiated this work with the aim of establishing the correlation between primary open-angle glaucoma and sleep apnea symptoms in melanoderms in Côte d'Ivoire.

2. Patients and Method

The authors conducted a prospective cross-sectional case-control study with an analytical focus over a 12-month period from January 2022 to December 2023, recruiting patients successively from the ophthalmology department of Treichville University Hospital. The study population comprised two subgroups: a case subgroup consisting of patients known to and regularly monitored by the depart-

ment for glaucoma, and a control subgroup consisting of patients without glaucoma. The inclusion criteria were any black African patient over 20 years of age, regardless of gender, known to have glaucoma for the cases or not to have glaucoma for the controls. A history of eye trauma with visual sequelae and eye surgery, pregnant women and patients with unbalanced defects were not included in the study. Informed consent was obtained from all patients. We proceeded with successive recruitment using an anonymous oral questionnaire. This work took into account ethical and professional considerations in accordance with the principles of the Declaration of Helsinki. The case-control study required homogeneity between the glaucoma and non-glaucoma subgroups. The p-value of the Student's t-test was used to verify this homogeneity. The comparison parameters were epidemiological: sex, age, education level and occupation; clinical: family history of glaucoma and factors such as high blood pressure, diabetes and obesity were investigated. Symptoms of obstructive sleep apnea syndrome (OSAS) were defined according to the criteria of the American Academy of Sleep Medicine (AASM), using the Epworth scale and the ODSI (Observation and Interview-based Diurnal Sleepiness Inventory) questionnaire to assess daytime sleepiness in passive and active situations. These scales were used as screening tools to identify populations at risk of OSA. The diagnosis was essentially clinical. The data were entered and processed using Microsoft 2016 and Epi Info 7 version 1.3 software. The chi-square test with a significance threshold of less than 5% and the odds ratio were used for the analytical study.

3. Results

The study included 159 individuals, 91 of whom were men, for a sex ratio of 1.34. In our series, sex was not associated with the onset of glaucoma (p = 0.95). The subgroups consisted of 79 glaucoma patients (49.69%) and 80 non-glaucoma patients (50.31%). The glaucoma population consisted mainly of people over the age of 50, representing 63.29%. However, most of the control group were under the age of 50 in 56.25% (**Figure 1**). There was a statistically significant link between age and the onset of glaucoma (p = 0.002).

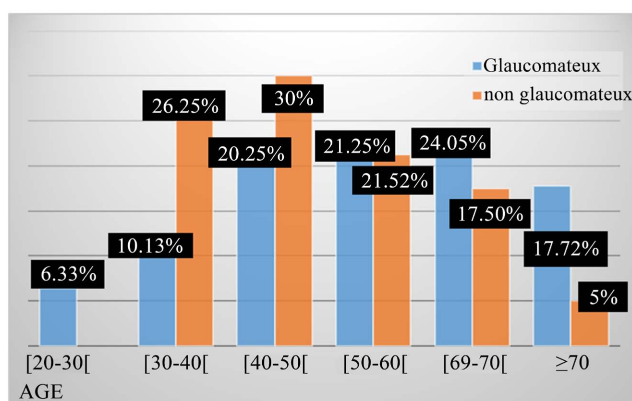

Figure 1. Distribution of glaucoma patients and non-glaucoma patients by age group.

A family history of glaucoma was noted in 40.51% of glaucoma patients. Clinically, the glaucoma population included more snorers (63.29%) than the non-glaucoma population (36.25%) (**Table 1**). With regard to daytime sleepiness, on the Epworth scale, 73.68% of glaucoma patients had a score greater than 10. In contrast, a score greater than 10 was observed in 26.32% of non-glaucoma patients (**Table 2**). According to the ODSI questionnaire, 72.22% of glaucoma patients had daytime sleepiness (score greater than or equal to 6); in comparison, the proportion of control subjects was 27.78% (**Table 3**). There was a statistically significant link between snoring (p = 0.001), daytime sleepiness according to the Epworth scale (p = 0.001) and according to the ODSI questionnaire (p = 0.003), and the occurrence of primary open-angle glaucoma.

Table 1. Relationship between snoring and glaucoma.

	Non glaucomatous		**glaucomatous**		**Total**		
Snoring	Workforce	%	Workforce	%	Workforce	%	**p-value = 0.001** **OR = 3.03** **IC = (1.59; 5.78)**
Yes	29	36.71	50	63.29	79	100	
No	51	63.75	29	36.25	80	100	
Total	80		79		159	100	

Table 2. Relationship between daytime sleepiness and glaucoma on the Epworth scale.

	Non glaucomatous		**glaucomatous**		**Total**		
Daytime sleepiness	Workforce	%	Workforce	%	Workforce	%	**p-value = 0.001** **OR = 3.4** **IC = (1.71; 8.61)**
less than 10	70	57.85	51	42.15	121	100	
greater than or equal to 10	10	26.32	28	73.68	38	100	
Total	80		79		159	100	

Table 3. Relationship between daytime sleepiness and glaucoma according to the ODSI questionnaire.

	Non glaucomatous		**glaucomatous**		**Total**		
Daytime sleepiness	Workforce	%	Workforce	%	Workforce	%	**p-value = 0.003** **OR = 3.433** **IC = (1.52; 7.73)**
Less than 6	70	56.91	53	43.09	123	100	
greater than or equal to 6	10	27.78	28	72.22	36	100	
Total	80		79		159	100	

4. Discussion

Primary open-angle glaucoma (POAG) is a chronic multifactorial disease whose pathophysiology is still under discussion. Family history has been strongly documented among glaucoma patients, in some patients, despite satisfactory pressure control, glaucoma progresses, causing visual field deterioration [4]. This demonstrates that the management of chronic glaucoma should take into account both ocular and extraocular risk factors [5] [6]. Non-pressure factors play an equally

important role, and correcting them would optimise the treatment of POAG. Among these non-pressure factors, obstructive sleep apnea syndrome has been mentioned in the literature. Its global prevalence in the adult population is estimated at 4% according to Young's original study [7]. However, OSAS remains little known to the general public and even to some healthcare professionals. As a result, it remains largely underdiagnosed. The symptoms include both subjective and objective signs. Due to its cardiovascular, ophthalmological and general consequences, obstructive sleep apnea syndrome, like primary open-angle glaucoma, represents a public health problem. The breathing pauses that occur during OSA are thought to cause microcirculatory disorders in the optic nerve head [8] [9]. According to Khahy, the signs of OSA appear to be more common in glaucoma patients [9]. The work published by Flammer confirms this association [10]. However, in sub-Saharan Africa, very few studies have addressed this topic. The aim was therefore to evaluate the link between OSAS and glaucoma in African melanoderms. In our series, the diagnosis of OSA was clinical, based on specific criteria known from the literature. This decision to focus on clinical symptoms was justified by the high cost of paraclinical investigations of OSA for the public sector. However, this exclusively clinical screening could be a limitation of this study. The prevalence of OSA increases with age, decade by decade, from the age of 40 onwards, due to a physiological acceleration in the destruction of ganglion cells and their axons [5]. In our series, patients aged between 40 and 60 accounted for half of the population. POAG was mainly observed in patients over the age of 50 (63.29%) with a statistically significant association [p = 0.002]. Sounouvou in Benin found 28.1% of glaucoma cases in a similar age group [11]. However, studies conducted in Mali reported a proportion of 15.5% of glaucoma patients in a younger age group between 40 and 49 years old [12]. This difference is thought to be due to sampling bias and differences in study methodology. Nevertheless, all of these results suggest that POAG is a condition affecting mature adults and increases with age. The link between (POAG) and (OSA) has been mentioned by several authors [10] [13]. The clinical picture of OSAS mainly combines major nocturnal symptoms such as loud snoring with frequent awakenings and/or nocturia, and daytime signs such as morning asthenia, headaches, and daytime hypersomnolence. Existing subjective sleepiness assessment scales help clinicians quantify the severity of sleepiness. The most widely used scales, which were used in this study, are the Epworth Sleepiness Scale and the ODSI questionnaire, which quantify the duration of daytime sleepiness. As they have been approved by the WHO, these scales are considered to be more suitable for our local populations [14]. Snoring is a cardinal sign found in 70 to 95% of patients with OSA, according to the literature [15]. In our series, the proportion of snoring was approximately 63% in glaucoma patients versus 37% in non-glaucoma patients. There was a link between snoring and glaucoma (p = 0.0001). Being a night-time snorer also conferred a threefold increase in the risk of developing POAG. According to Blumen and Onen, the proportions of snoring among glaucoma patients were 49% and 47% respectively [16] [17]. The pathophysiological consequence could explain its

significant prevalence. Chronic snoring leads to hypoxia and hypercapnia, which are responsible for the progressive destruction of the optic nerve head. Daytime sleepiness is another key sign of OSA. During OSA, the body tries to compensate for partial or total respiratory obstruction by generating micro-awakenings to prevent asphyxia. These nocturnal micro-awakenings lead to reduced sleep time, resulting in excessive daytime sleepiness. In our study, daytime sleepiness was assessed using the Epworth Scale and the ODSI questionnaire. Elsewhere, a study conducted by Kouadio showed that 45.45% of patients who presented with daytime sleepiness according to the Epworth Scale had OSA [18]. Our series noted 54.90% of glaucoma patients with excessive daytime sleepiness versus 14.28% in the control group. Excessive daytime sleepiness was therefore linked to glaucoma ($p = 0.001$). Having daytime sleepiness also exposes patients to a four times higher risk of developing glaucoma. Although polysomnography is the gold standard for documenting abnormal respiratory events occurring during sleep and confirming OSA, the combination of clinical arguments such as nocturnal snoring and daytime sleepiness, as well as other functional signs, is useful in the diagnosis of OSA. The Epworth scale, based on the search for clinical symptoms, is useful in revealing more pronounced daytime sleepiness in patients with OSA. Similarly, in the ODSI questionnaire, there was a significant correlation between high scores and the presence of glaucoma, once again confirming the significant link between POAG and OSA symptoms. For some authors, OSA could be considered a factor that aggravates glaucoma, rather than a primary cause. Understanding the frequency of this association is therefore essential for better management of glaucoma in patients at risk of OSA [8] [17].

This observation reinforces data from the literature suggesting a bidirectional link between the two conditions. Intermittent hypoxia and fluctuations in nocturnal intraocular pressure could play a key role in the worsening of glaucoma [6] [19]. Untreated sleep disorders may accelerate glaucoma progression. Western studies have shown similar results, but this study makes an essential contribution in the African context, where scientific data on the subject is insufficient. The low level of awareness of OSAS among the populations studied poses a challenge for early detection. It should be integrated into the management of primary open-angle glaucoma using validated questionnaires such as the Epworth scale and the ODSI. Increased collaboration between ophthalmologists and sleep specialists would be beneficial for identifying patients at risk. Despite relevant results, one of the limitations of this study remains the small sample size and its monocentric nature, which should prompt a larger cohort to confirm these data within African community populations.

5. Conclusion

Primary open-angle glaucoma is a chronic anterior optic neuropathy that causes blindness. In some cases, its progression defies understanding of the pathophysiological mechanisms. The study highlighted a significant correlation between primary open-angle glaucoma and the symptoms of sleep apnea syndrome. It is

therefore important to ensure that systemic risk factors are corrected. These results justify systematic screening for sleep apnea syndrome in black African glaucoma patients. In addition to controlling intraocular pressure, the therapeutic strategy for OSAS associated with glaucoma should be part of a multidisciplinary approach to ensure better follow-up and prevent cardiovascular disease.

Authors' Contributions

All authors who contributed to this work have declared that they have read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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