Progression of Primary Open Angle Glaucoma on Optical Coherence Tomography of the Optic Nerve Head

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Abstract

Aims: To describe the progression of Primary open angle glaucoma (POAG) on Optical Coherence Tomography (OCT) of the optic nerve head and retinal nerve fiber layers (RNFL). **Method:** We conducted a descriptive retrospective study from January 1, 2015 to December 31, 2019, a period of 5 years from the files of patients followed for POAG and having carried out at least two OCT examinations of the optic nerve head (ONH), one automated visual field and Intraocular pression (IOP). The variables studied were: age, sex, mean IOP, glaucoma stage, progression of ONH parameters, and progression of RNFL parameters. **Results:** During the period, 112 eyes of 56 patients were included. The mean age was 48.96 ± 16.57 [12 - 83] years with a sex-ratio of 1.33 (32 M/27 F). The mean IOP was 21 ± 4.54 [10 - 36] mm Hg. According to the mean deviation (MD) of the visual field, 98 eyes or 87.5% were stage 1 of POAG, 10 eyes or 8.9% at stage 2 and 4 eyes or 3.6% at stage 3. The mean time between the 1st and 2nd OCT examination was 28.91 ± 11.07 [6 - 56] months, corresponding to an average of 2.18 OCT per patient in 5 years of follow-up. There was an average increase of 6.2% of the Cup area and an increase in the vertical Cup/Disc ratio of 1.79% per year. The thinning average of neuro-retinal ring area was 1.64% per year. The RNFL thickness had decreased on average by 4.28 μ or 0.93% per year. The lower quadrant had the highest fiber loss with 1.08% per year followed by the upper quadrant with a loss of 1.05% per year. **Conclusion:** OCT of the ONH and RNFL proves to be an essential tool in the follow-up of POAG. A subsequent study taking into account the OCT of the macular ganglion complex will enable to study its

contribution in the follow-up of glaucomatous patients in the same population.

Keywords

POAG, Progression, OCT ONH-RNFL

1. Introduction

Primary open-angle glaucoma (POAG) is a chronic, progressive, blinding, irreversible optic neuropathy characterized by damage to the optic nerve head and retinal nerve fibers with subsequent visual field defects. The iridocorneal angle is normal, and the major risk factors are elevated intraocular pressure and advanced age. Visual deficits can be prevented by early diagnosis and treatment [1]. Glaucoma is the first cause of irreversible blindness and represents approximately 15% of all causes of blindness [2]. This makes it a real public health problem. In 2020, glaucoma affected about 80 million people worldwide, with nearly 75% of open-angle glaucoma [3]. The diagnosis of POAG is based on a range of both clinical and para-clinical arguments. These are based on explorations of functional analyzes and more recently structural analyses. Optical coherence tomography or OCT is the most recent structural analysis tool used in the diagnosis and in the follow-up of POAG. OCT is an indispensable tool in monitoring the progression of POAG, through the analysis of the Optic nerve head (ONH), the retinal nerve fiber layer (RFFL) and macular ganglion cell complex [4] [5], but the visual field remains of interest because it alone reflects functional changes [6] [7]. POAG occurs at a younger age in melanoderma [8] and evolves more aggressively compared to European [9]. What is the progression of POAG to OCT in African melanoderma population? The present study aims to investigate the progression of POAG in melanoderma at OCT of ONH and RNFL.

2. Materials and Methods

<u>Type of study</u>: from January 1, 2015 to December 31, 2019, *i.e.* a period of 5 years, on the patient's records followed for POAG.

<u>Setting and study population</u>: Our study took place in AFIA Eye Clinic in Lomé, the capital of Togo. Togo is a West African country located between the 6th and 11th degree of North latitude; limited to the north by Burkina-Faso, to the east by Benin, to the west by Ghana and to the south by the Atlantic Ocean. Its area is 56,600 km^2 with a population estimated at 8.6 million in 2020, with a distribution of 49.30% men and 50.70% women. The density is 152 inhabitants per km^2 (Koubogbé 2015) [10].

<u>Inclusion criteria</u>: The target population of this study consists of patients of all ages with a complete medical file regularly followed for POAG in AFIA Eye Clinic in Lomé. We have included in this study all records of patients followed up at least 1 year for POAG and who performed at least two (02) OCT imaging

of the ONH and RNFL, an automated visual field (CVA) and an intraocular pressure (IOP).

<u>Parameters studied</u>: were age, sex, IOP, POAG stages, variations in the OCT parameters of the ONH and RNFL: Area of the ONH, of the excavation and of the neuro-retinal ring, the cup/disc ratio, the overall mean RNFL thickness, the thickness of RNFL in the four quadrants. POAG stage was determined using the Glaucoma Staging system based on visual field Mead deviation score (Mills, 2006) [11].

<u>Statistical analysis</u>: We performed data analysis using R-Studio Version 1.2.5033 software. We presented quantitative variables as average ± standard deviation and qualitative variables as percentages.

<u>Ethical consideration</u>: We conducted our study in compliance with the rules of ethics and professional conduct relating to the practice of medicine and in compliance with the Declaration of Helsinki.

3. Results

<u>Sociodemographic aspects</u>: We have included 112 eyes of 56 patients, *i.e.* 56 right eyes and 56 left eyes. The average age of the patients was 48.96 ± 16.57 years with extremes of 12 and 83 years. The most represented age group was 52 - 62 years with 25% (14/56) (Figure 1). There was a male predominance with a sex ratio of 1.33 (32 M/27 F). The mean follow-up time was 2.5 ± 1.2 years with extreme of 1 years and 5 years.

<u>Clinical aspects</u>: The mean intraocular pressure was 21 ± 4.54 [10 - 36] mm Hg. According to the mean visual field deviation, 98 eyes or 87.5% were at Early stage (stage 1; MD < −6 dB) of POAG, 10 eyes or 8.9% at Moderate stage (Stage 2; −12 < MD < −6) and 4 eyes or 3.6% at Advanced stage (stage 3; −20 < MD < −12).

<u>Follow up</u>: Over the 5-year follow-up period, 82.15% (46/56) of patients performed two OCT examinations and 17.85% (10/56) of patients performed three OCT examinations. The average time between the 1st and the 2nd OCT was 28.91 ± 11.07 [6 - 56] months and the average time between the 2nd and the 3rd OCT was 23 ± 7.7 [11 - 32] months. The average number of OCT was 2.18 OCT per patient in 5 years of follow-up.

<u>Progression</u>:

There was an annual average increase of 1.24% in the surface of the cup and an annual average increase in the vertical Cup/Disc ratio of 1.79%. Surface thinning of the neuro-retinal rim was an annual average of 1.64%. The thickness of the RNFL had decreased in annual average by 0.93% per year. Table 1 summarizes the progression of ONH and RNFL.

There was an average increase of 46.66% in the number of affected quadrants with a 14.4% new lesions in the Superior quadrant (Table 2). The Inferior quadrant had the highest fiber loss with 1.15 μ/year *i.e.* 1.08% per year followed by the superior quadrant with a loss of 1.01 μ *i.e.* 1.05% per year as shown in Table 3.
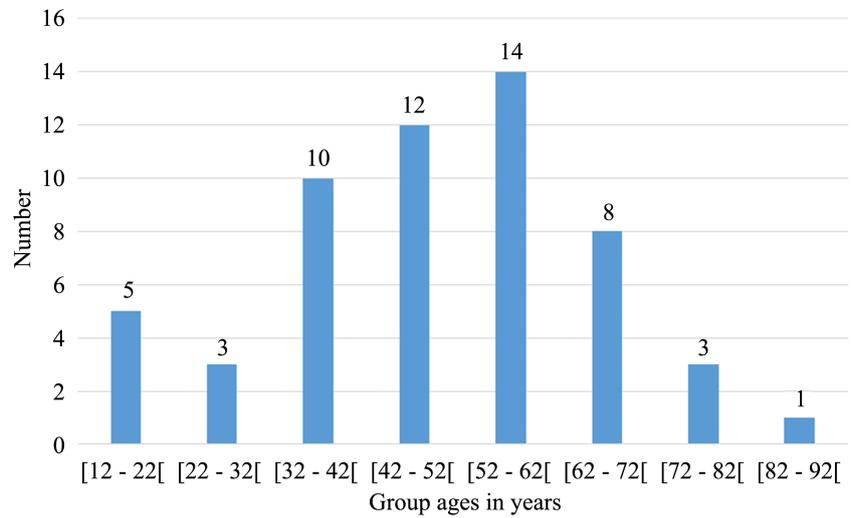
Figure 1. Patients repartition according to group ages.

Table 1. Progression of optic nerve head and retinal Nerf fiber layer parameters.

	Beginning	End	Difference	Percentage	Percentage/year
Cup Area (μm²)	1.45	1.36	0.09	6.20%	1.24%/year
Rim Area (μm²)	1.34	1.23	0.11	−8.21%	−1.64%/year
C/D ratio	0.73	0.67	0.06	8.95%	1.79%/year
RNFL thickness (μm)	91.99	87.71	4.28	−4.65%	−0.9%/year

Table 2. Progression of quadrant according to apparition of new attempt.

	Beginning	End	Difference	Percentage
Superior quadrant	15	28	13	**14.44%**
Inferior quadrant	23	33	10	11.12%
Nasal quadrant	14	26	12	13.33%
Temporal quadrant	38	45	7	7.77%
Total	90	132	42	46.66%

Table 3. Mean RNFL thickness loss according to quadrants.

	Loss (μ)	Loss (μ/an)	Percentage (%)	Percentage/year
Superior quadrant	4.28	0.86	5.26	1.05
Inferior quadrant	3.16	0.63	5.41	**1.08**
Nasal quadrant	5.07	1.01	4.51	0.90
Temporal quadrant	5.79	1.15	4.91	0.98

4. Discussion

The mean age in our study was 48.96 ± 16.57 years, with a sex ratio (M/F) of

1.33. These results are consistent with the literature where high prevalence of POAG after age 40 and male predominance have been described [12].

In our study, an average of 2.18 OCT per patient had been performed over 5 years of follow-up. About double of this average was reported by Seth *et al.* [13] in 2017 in India who has reported 4.2 OCT per patient. The low number of OCT performed in our study could be due to financial reasons [14] and the difficulty of honoring control appointments by patients.

We have noticed an increase in the surface of the cup as well as an increase in the vertical Cup/Disc ratio and a thinning of the surface of the neuro-retinal rim. These results agree with the definition of glaucoma [1] and are consistent with data from the literature [13] [15]. Our study showed that the upper quadrant is where new lesions appear the most and that losses are most noticeable in the lower quadrant. The average annual thinning of RNFL was 0.93% in our study. Seth *et al.* [13] reported an average decrease in RNFL of 1.3% per year for a follow-up of 6.6 years. These results are close to ours but the difference could be explained by the longer follow-up time of 6.6 years in Seth's study [13]. The lower quadrant presented the highest loss of fibers with 1.15 μ/year *i.e.* 1.08% per year followed by the upper quadrant with a loss of 1.01 μ *i.e.* 1.05% per year in our study. Seth *et al.* [13] found a loss of 2.90% and 2.61% on average per year, respectively in the upper and lower quadrants. This discrepancy could be explained by the age difference between the samples, younger in our study, 48 years against 54 years in Seth's sample [13]. According to data from the literature, some authors have suggested that a change in the average thickness of the peripapillary nerve fibers from 1.25 to 1.56 microns per year was suspicious for progression of glaucoma [4] [16]. Other authors had found losses lower than our results, such as Wu *et al.* [17] who noted a mean decrease correlated with age in fibers per quadrant of 0.23 to 0.54 microns per year. Furthermore, Leung *et al.* [16] were able to observe that the deficits were essentially located in the superior temporal and inferior temporal sectors. This confirmed the areas of vulnerability described histologically. Although our study did not focus on the macular ganglion cell complex, several studies report the superiority of the analysis of the macular ganglion complex on RNFL, especially in advanced glaucoma [18] [19]. OCT-angiography (OCT-A) would show real potential by providing new information on the pathophysiology of glaucoma or even to help in the diagnosis of glaucoma or its progression [20].

The limits of our study are undoubtedly the sample modest size. Several factors explained the weakness of our sample: the difficulty of honoring examinations due to the limited financial level of patients in a context of insufficient health insurance coverage and the non-compliance of other patients with control appointments.

5. Conclusion

OCT of the ONH and RNFL proves to be an essential tool in the follow-up of

POAG. Given the variability of RNFL thickness and the floor effect in advanced glaucoma, a subsequent study taking into account the OCT of the macular ganglion complex will enable to study its contribution in the follow-up of glaucomatous patients.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Abbreviations and Symbols

OCT: Optical Coherence Tomography

POAG: Primary Open Angle Glaucoma

ONH: Optic Nerve Head

RNFL: Retinal Nerves Fiber Layer

IOP: Intra Ocular Pressure