Research Article

ISSN 2639-9482

Ophthalmology Research

Variation of Refraction Measurement before then under Cycloplegia about 25 Patients in the Ophthalmology Department of Bouaké University Hospital

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Received: 02 Oct 2023; **Accepted:** 08 Nov 2023; **Published:** 15 Nov 2023

Citation: Yves O, Zana D, Ella GL, et al. Variation of Refraction Measurement before then under Cycloplegia about 25 Patients in the Ophthalmology Department of Bouaké University Hospital. Ophthalmol Res. 2023; 6(1); 1-7.

ABSTRACT

Introduction: *The aim of this work was to measure the impact of cycloplegia on the precision of the correction of refractive errors in our conditions.*

Material and Methods: *This was a prospective and transversal study with descriptive aims on 25 patients (N=50 eyes) who underwent an objective study of refraction using an automatic refractometer before, then under cycloplegia. The patients' optical correction adjusted subjectively from the values of the refraction under cycloplegia, was also recorded, and all values were converted to spherical equivalents for analysis.*

Results: *The patients were aged 7 to 37 years (average 20.6 +/-8.35 years) with a predominance of women (64%) and most pupils and students (84%). The most frequent reasons for consultation were headache (18.10%), photophobia (14.66%), eye pain (13.8%), ocular itching and tearing (12.93% each). The measurement of refraction before cycloplegia revealed in spherical equivalents, 82% myopia, 16% hyperopia and 2% emmetropia. Under cycloplegia, there was 20% myopia, 72% hyperopia and 8% emmetropia. After optical correction, the distribution of refractive errors, in spherical equivalent, was 24% (n=12) myopia, 72% (n=36) hyperopia and 4% (n=2) emmetropia.*

Conclusion: *The reduction in visual acuity felt or expressed is a poor indicator of the existence of a refractive error in children. Precise correction of this requires cycloplegia, especially since the subjects are young or present symptoms such as headaches, photophobia or oculalgia, even with "normal" uncorrected distance visual acuity.*

Keywords

Refractive error-cycloplegia-optical correction.

Introduction

The refraction of the eye designates the overall refractive power of all the ocular media crossed by the light, which enters the eye, up to the retina. This corresponds to the sum of the refractive powers of all the ocular diopters, separated by media with different refractive indices [1]. Under normal conditions or emmetropia, the image of an object located at infinity is focused on the retina and is perceived clearly. All situations where the optical system does not allow this focusing represent refractive errors or ametropia [2]. The precision of vision is then affected and we speak of a decline in visual acuity. Refractive errors are therefore optical defects of the eye. The aim of the refraction test is to identify and measure the extent of the optical defect in the eye (ametropia). This measurement is carried out eye by eye, then using binocular vision. In young subjects, the power of accommodation of the lens can "mask" a refractive error and be the cause of a poor measurement of it. This is the whole point of cycloplegia, which consists of pharmacologically and reversibly "paralyzing" the ciliary muscle of the eye on which accommodation depends [3]. Thus, the measured value of the refractive error after cycloplegia comes as close as possible to the value necessary for compensation of the optical defect of the eye. This allows an objective study of the refraction and the implementation of total optical correction [4]. The interest of such a study lies in the fact that in a study on refractive errors in children, Ouattara et al. demonstrated a documented use of cycloplegia of 53.8% [5]. Its aim is to contribute to better management of refractive errors in Ivory Coast and more particularly to the ophthalmology department of the Bouaké University Hospital.

Material and Methods

This was a prospective cross-sectional study with a descriptive aim of the variations in refractions of patients without, then after, cycloplegia carried out with cyclopentolate hydrochloride 0.5% eye drops. The patients were recruited from among those who came for consultation for any reason and gave verbal consent when they reached the age of majority. When they were minors, this consent was obtained from the parent(s) present. Data collection was carried out on an individual and anonymous survey form. The variables studied were the patient's sociodemographic data (age, sex, socio-professional category, race, and place of residence), reason for consultation, uncorrected distance visual acuity, refraction value measured with an automatic refractometer before cycloplegia. (Value of the sphere and value and axis of the cylinder), and converted into spherical equivalent, the value of the refraction measured with the automatic refractometer after cycloplegia and converted into spherical equivalent. Finally, the value of the optical correction adjusted subjectively from the value of the refraction under cycloplegia, and this optical correction also converted into a spherical equivalent. Cycloplegia was performed according to the following protocol: one drop at times T0, T15 and T30. T0 corresponded to the time when the first drop of the cycloplegic had been instilled, T15 corresponded to the fifteenth minute after the instillation of the first drop and T30 corresponded to the thirtieth minute after the instillation of the first drop and T45 corresponded to the forty- fifth minute after instilling the first drop. The refraction measurement was made again at T45. After this step, the patient benefited from the "subjectively" adjusted optical correction, and its spherical equivalent recorded for each eye. Throughout the process, Monoyer or Snellen decimal scales were used.

Results

In total, 25 black patients were selected, i.e. 50 eyes. The average age was 20.6 (+/-8.35) years with extremes of 7 and 37 years. The age group of 10 to 20 years represented 44% of cases. Female patients represented 64%, or a sex ratio of 0.56. Pupils and students represented 84% of socio-professional categories. The reasons for consultations were dominated by headaches (18.1%), followed by photophobia (14.66%). Visual blurring was fifth in order of frequency (Table 1). The measurement of distance visual acuity without correction of both eyes was superimposable with 76% of acuities between 8/10th and 10/10th (Figure 1). After optical correction, visual acuity of between 8/10th and 10/10th was found at 88% in the right eye and 92% in the left eye, i.e. an average of 90%. (Figure 2). In spherical equivalents, the objective measurement of refraction without cycloplegia on the 50 eyes revealed 41 myopic eyes (82%), 8 hyperopic eyes (16%) and 1 eye (2%) emmetropic (Table 2 and Figure 3). The same measurement after cycloplegia revealed 10 myopic eyes (20%), 35 hyperopic eyes (70%) and 5 emmetropic eyes (10%), in spherical equivalents (Table 3 and Figure 4). The "subjectively adjusted" optical correction based on the objective measurement of refraction after cycloplegia revealed 12 myopic eyes (24%), 36 hyperopic eyes (72%) and 2 emmetropic eyes (4%) in spherical equivalents (Table 4 and Figure 5). In real values, before cycloplegia, the objective measurement of refraction had revealed 13 cases of myopia (26%), 4 cases of hyperopia (8%), 31 cases of compound or mixed astigmatism (62%). and 2 cases (4%) of myopic astigmatism (Table 2). After cycloplegia, objective measurement of refraction revealed no case of myopia (0%), 8 cases of hyperopia (16%), 39 cases of compound or mixed astigmatism (78%), 1 case of emmetropia (2%), and 2 cases (4%) of myopic astigmatism (Table 3). After subjectively adjusted optical correction, we found no case of myopia (0%), 26 cases of hyperopia (52%), 4 cases of compound or mixed astigmatism (8%), 12 cases of myopic astigmatism (24%) and 8 cases (16%) of hyperopic astigmatism (Table 4).

Table 1: Distribution of patients according to reason for consultation.

Reason for consultation	Number	Frequency (%)
Headaches	21	18,10
Photophobia	17	14,66
Eye pain	16	13,80
Ocular itching	15	12,93
Tearing	15	12,93
Eye redness	11	9,48
Visual blur	11	9,48
Eye tingling	10	8,62
TOTAL	**116**	**100**

Figure 1: Distribution of distance visual acuities, without correction (OD= right eye; OG= left eye).

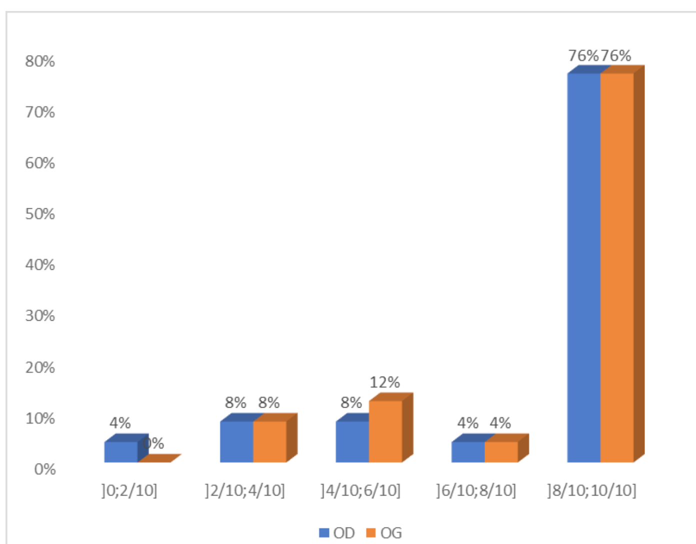

Table 2: Results of objective refraction measured with an automatic refractometer without cycloplegia, in real values (sphere, cylinder value and axis) and in spherical equivalents (OD= right eye; OG= left eye).

Identifier		Objective refraction without cycloplegia	
		Formula (sphere, cylinder value and axis)	Spherical equivalent
N°01	OD	-1,00 (-0,50; 145°)	-1,25
	OG	-0,75 (-0,25; 167°)	-0,87
N°02	OD	+0,50 (-2,25; 175°)	-0,62
	OG	+0,25 (-1,50; 2°)	-0,50
N°03	OD	-0,50	-0,50
	OG	-1,00	-1,00
N°04	OD	0,00 (-0,75; 175°)	-0,37
	OG	-0,25 (-0,50; 175°)	-0,50
N°05	OD	-0,75 (-1,75; 10°)	-1,62
	OG	-0,75 (-4,00; 170°)	-2,75
N°06	OD	-0,25 (0,00)	-0,25
	OG	-0,75 (0,00)	-0,75
N°07	OD	-3,50 (-0,75; 1°)	-3,87
	OG	-3,75 (-1,00; 180°)	-4,00
N°08	OD	-1,00 (-0,25; 110°)	-1,12
	OG	-0,25 (0,00)	-0,25
N°09	OD	-1,00 (-0,25 ; 130°)	-1,12
	OG	-0,75 (-0,25 ; 110°)	-0,87
N°10	OD	-0,50 (-0,75 ; 70°)	-0,87
	OG	-1,00 (-0,75 ; 150°)	-1,37
N°11	OD	-1,00 (-0,75 ; 20°)	-1,37
	OG	-1,25 (-1,00 ; 30°)	-1,75
N°12	OD	1,50 (-3,50 ; 175°)	-0,25
	OG	0,50 (-1,50 ; 5°)	-0,25
N°13	OD	-1,50 (-0,50 ; 15°)	-1,75
	OG	-0,75 (-1,25 ; 160°)	-1,37
N°14	OD	+0,25 (0,00)	+0,25
	OG	+0,50 (0,00)	+0,50
N°15	OD	-0,25 (0,00)	-0,25
	OG	-0,50 (0,00)	-0,50
N°16	OD	-0,25 (0,00)	-0,25
	OG	-0,25 (-0,50 ; 130°)	-0,50
N°17	OD	+0,25 (0,00)	+0,25
	OG	-0,25 (0,00)	-0,25
N°18	OD OG	-0,25 (0,00) -0,50 (0,00)	-0,25 -0,50
N°19	OD	0,00 (-0,50 ; 176°)	-0,25
	OG	0,00 (0,00)	0,00
N°20	OD	+0,25 (0,00)	+0,25
	OG	-0,25 (0,00)	-0,25
N°21	OD	+1,00 (-0,50 ; 28°)	+0,75
	OG	+1,25 (-1,00 ; 157°)	+0,75
N°22	OD	-0,25 (0,00)	-0,25
	OG	-0,25 (-0,25 ; 109°)	-0,37
N°23	OD	+0,75 (-0,75 ; 178°)	+0,38
	OG	+1,00 (-0,75 ; 175°)	+0,62
N°24	OD	-0,25 (-0,50 ; 7°)	-0,50
	OG	+0,25 (-0,75 ; 160°)	-0,12
N°25	OD	-1,00 (-0,50 ; 152°)	-1,25
	OG	-1,25 (-0,25 ; 165°)	-1,37

Table 3: Results of objective refraction measured with an automatic refractometer under cycloplegia, in real values and in spherical equivalents (OD= right eye ; OG= left eye).

Identifier		Objective réfraction under cycloplegia	
		Formula	Spherical equivalent
N° 01	OD	-1,00 (-0,50 ; 145°)	-1,25
	OG	-0,75 (-0,25; 167°)	-0,87
N°02	OD	+0,50 (-0,75; 160°)	+0,13
	OG	+0,25 (-1,50; 180°)	-0,50
N°03	OD	+0,75	+0,75
	OG	+0,50 (-0,50; 166°)	+0,25
N°04	OD	+0,75 (-1,00; 5°)	+0,25
	OG	+0,75 (-1,00; 10°)	+0,25
N°05	OD	+2,00 (-4,25; 10°)	-0,12
	OG	+1,75 (-3,00; 170°)	+0,25
N°06	OD	+0,50 (-0,50; 45°)	+0,25
	OG	+0,75 (-0,25; 165°)	+0,63
N°07	OD	0,00 (-0,50; 175°)	-0,25
	OG	-0,25 (-0,50; 5°)	-0,50
N°08	OD	0,00 (0,00)	0,00
	OG	+0,25 (0,00)	+0,25
N°09	OD	+1,00 (-0,50 ; 115°)	+0,75
	OG	+0,25 (-0,50 ; 90°)	0,00
N°10	OD	+0,75 (-0,50 ; 20°)	+0,50
	OG	+0,50(-1,00 ; 165°)	+0,00
N°11	OD	+1,25 (-1,25 ; 90°)	+0,63
	OG	+1,25 (-1,50 ; 90°)	+0,50
N°12	OD	+1,50 (-3,75 ; 175°)	-0,37
	OG	+1,00 (-1,75 ; 5°)	+0,13
N°13	OD	+0,25 (-0,75 ; 15°)	-0,12
	OG	+0,50 (-1,00 ; 170°)	0,00
N°14	OD	+0,50 (-0,25 ; 10°)	+0,38
	OG	+0,75 (0,00)	+0,75
N°15	OD	+0,75 (-0,50 ; 180°)	+0,50
	OG	+0,75 (-0,50 ; 160°)	+0,50
N°16	OD	+0,50 (0,00)	+0,50
	OG	+0,25 (0,00)	+0,25
N°17	OD	+0,25 (-0,50 ; 175°)	0,00
	OG	+0,50 (-0,25 ; 150°)	+0,38
N°18	OD	+0,50 (-0,50 ; 167°)	+0,25
	OG	+0,50	+0,50
N°19	OD	+0,75 (-0,25 ; 162°)	+0,63
	OG	+0,75 (0,00)	+0,75
N°20	OD	+1,00 (-0,25 ; 41°)	+0,88
	OG	+0,75 (-0,25 ; 29°)	+0,63
N°21	OD	+1,25 (-1,00 ; 16°)	+0,75
	OG	+1,75 (-1,00 ; 163°)	+1,25
N°22	OD	+0,50 (0,00)	+0,50
	OG	+0,25 (0,00)	+0,25
N°23	OD	+1,25 (-0,75 ; 6°)	+0,88
	OG	+1,50 (-1,00 ; 176°)	+1,00
N°24	OD	+0,75 (-0,75 ; 10°)	+0,38
	OG	+1,00 (-1,00 ; 168°)	+0,50
N°25	OD	0,00 (-0,75 ; 166°)	-0,37
	OG	-0,75 (-0,50 ; 170°)	-1,00

Table 4: Results of optical correction subjectively adjusted from the objective measurement of refraction with an automatic refractometer after cycloplegia, in real values and in spherical equivalents (OD= right eye ; OG= left eye).

Identifier		Optical correction	
		Formula	Spherical equivalent
N°01	OD	(-0,50 ; 140°)	-0,25
	OG	(-0,50 ; 160°)	-0,25
N°02	OD	+0,25	+0,25
	OG	+0,25	+0,25
N°03	OD	+0,25	+0,25
	OG	+0,25	+0,25
N°04	OD	+0,25 (-0,50 ; 5°)	0,00
	OG	+0,25 (-0,50 ; 10°)	0,00
N°05	OD	+1,50	+1,50
	OG	+1,75	+1,75
N°06	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°07	OD	(-0,50 ; 180°)	-0,25
	OG	(-0,50 ; 180°)	-0,25
N°08	OD	(+0,50 ; 180°)	+0,25
	OG	(+0,50 ; 180°)	+0,25
N°09	OD	(+0,25 ; 180°)	+0,12
	OG	(+0,25 ; 180°)	+0,12
N°10	OD	(+0,25 ; 180°)	+0,12
	OG	(+0,25 ; 180°)	+0,12
N°11	OD	+1,00 (-1,00 ; 90°)	+0,50
	OG	+0,50 (-0,75 ; 90°)	+0,15
N°12	OD	(-2,75 ; 175°)	-1,37
	OG	(-1,00 ; 5°)	-0,50
N°13	OD	(-0,50 ; 15°)	-0,25
	OG	(-0,50 ; 170°)	-0,25
N°14	OD	+0,25	+0,25
	OG	+0,25	+0,25
N°15	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°16	OD	+0,25	+0,25
	OG	+0,25	+0,25
N°17	OD	(-0,50 ; 180°)	-0,25
	OG	(-0,50 ; 180°)	-0,25
N°18	OD	+0,25	+0,25
	OG	+0,25	+0,25
N°19	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°20	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°21	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°22	OD	(+0,25 ; 90°)	+0,12
	OG	(+0,25 ; 90°)	+0,12
N°23	OD	+1,25	+1,25
	OG	+1,25	+1,25
N°24	OD	+0,50	+0,50
	OG	+0,50	+0,50
N°25	OD	(-0,25 ; 180°)	-0,12
	OG	(-0,25 ; 180°)	-0,12

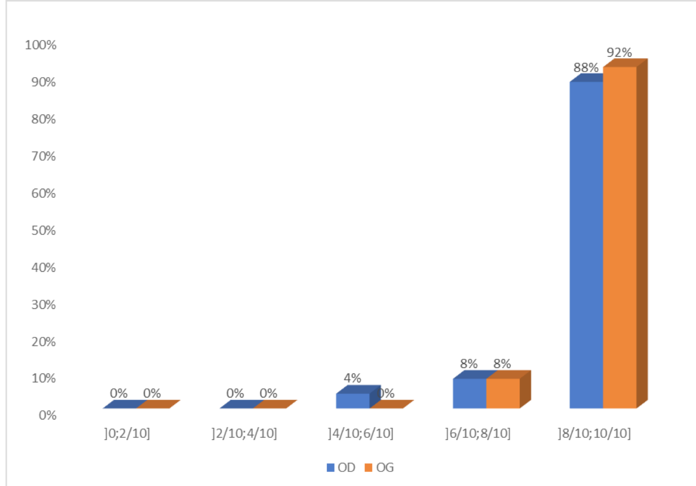

Figure 2: Distribution of distance visual acuities, after optical correction adjusted from the objective measurement of refraction under cycloplegia (OD= right eye; OG= left eye).

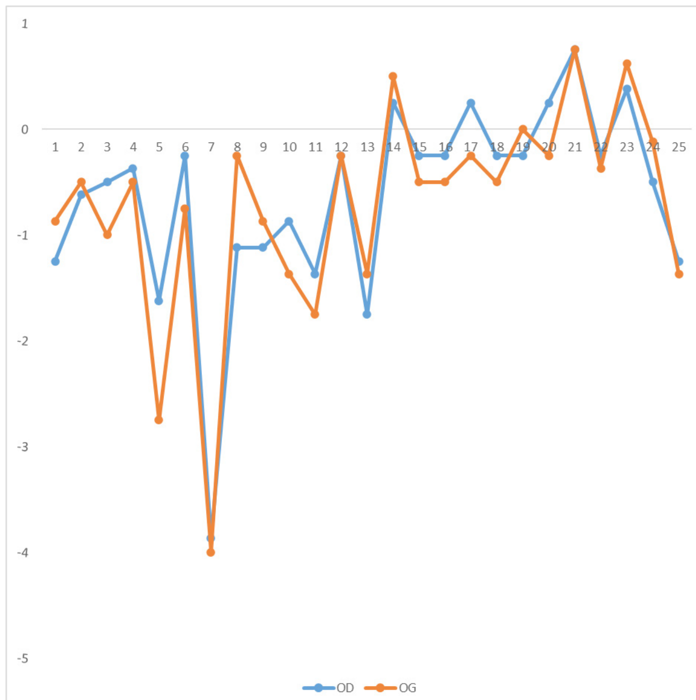

Figure 3: Graphical representation of the distribution of objective measurements of refraction without cycloplegia, as a function of the spherical equivalent (OD= right eye ; OG= left eye).

Discussion

The age of the patients was between 7 and 37 years with a mean age of 20.6+/-8.35 years. Our results align with those of Jeddi [6] who worked on patients aged 5 to 45 years with an average of 19.5+/- 9.7 years. Even if other authors [6,8] carried out the same study on younger subjects whose age range was between 1 and 17 years, they all used cycloplegia. Indeed, cycloplegic refraction is

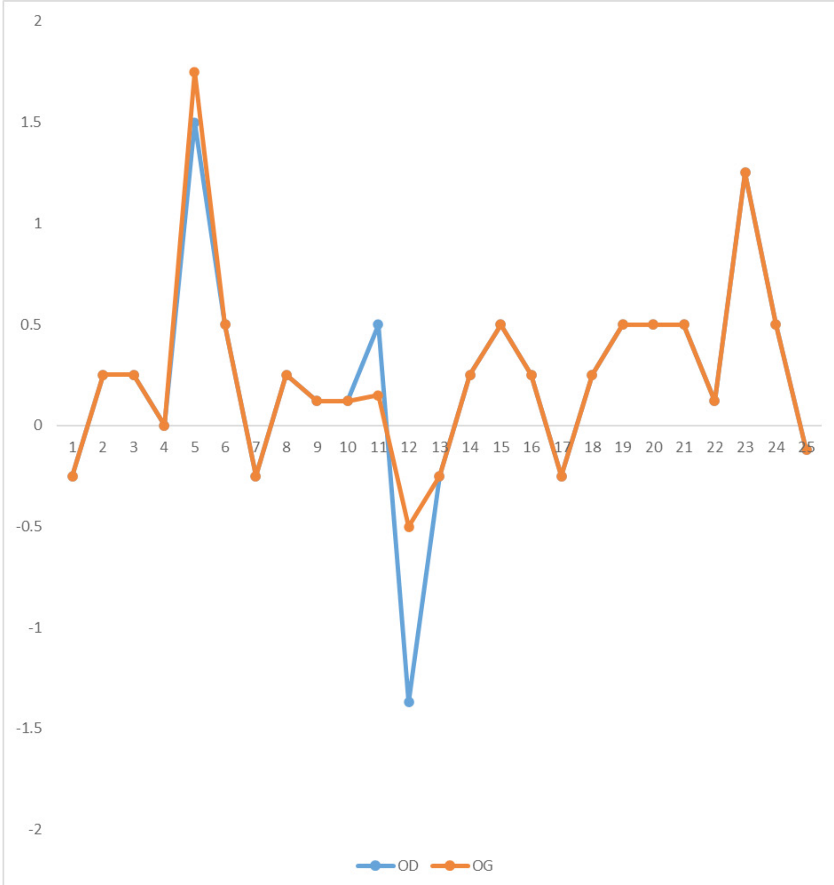

Figure 4: Graphic representation of the distribution of refractions measured objectively with an automatic refractometer under cycloplegia, as a function of the spherical equivalent (OD= right eye ; OG= left eye).

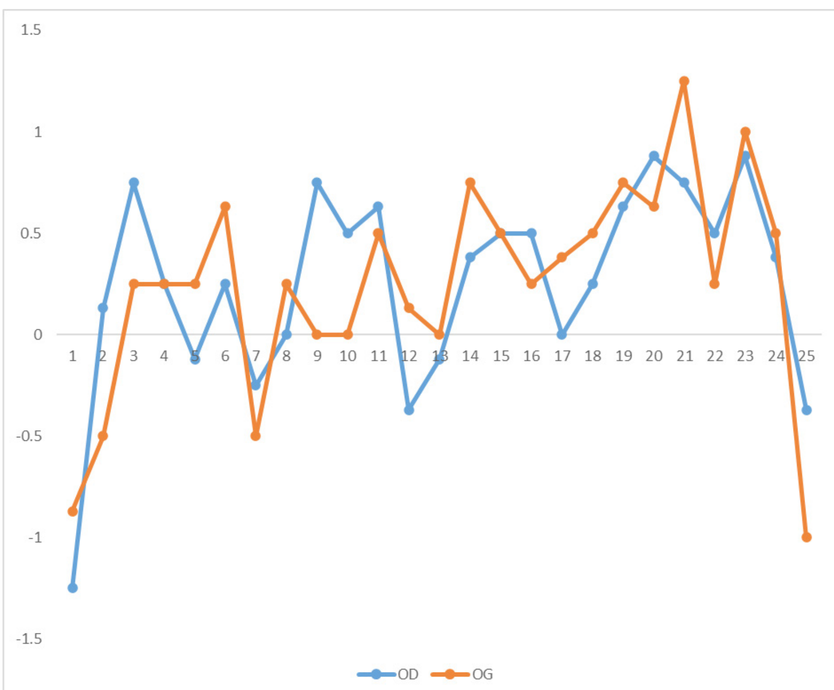

Figure 5: Graphic representation of the distribution of optical corrections adjusted from objective measurements of refraction with an automatic refractometer after cycloplegia, as a function of the spherical equivalent (OD= right eye ; OG= left eye).

most often used in subjects of preschool and school age because of the importance of sight in school systems and because of the active phenomenon of accommodation. However, accommodation would persist until the age of 45 [6], which would justify the use of a cycloplegic until this age. The female gender was predominant with 64% of cases. Our results align with those of Kouassi [9] who found 67.53% girls. However, Odoulami [8] in Benin had highlighted a slight male predominance of refractive errors, with 51.54%. The female predominance in certain studies like ours could be explained by the fact that girls express their health problems more, especially when they are young [5]. Headaches and photophobia were the most frequent reasons for consultation with 18.1% and 14.67%. "Visual blur" which could be compared to reduced visual acuity only comes in fifth place among the reasons for consultation. Our results are like those of Kouassi who had highlighted 15.10% of photophobia and 13.50% of headaches as the leading reasons for consultation within a school population [9]. These reasons for consultations confirm that refractive errors in young subjects are not always expressed by a perceived or expressed drop in visual acuity. Symptoms such as headache and photophobia should motivate careful objective study of refraction under cycloplegia. Distance visual acuity without correction was between 8/10th and 10/10th in 76% of cases. Our results agree with those of Zhao [10] and Maul [10] who respectively reported 84.2% and 87.2% good acuity. Furthermore, those from Pokharel [12] found a greater proportion of good visual acuity, at 97% in his study population. All these data confirm that the drop in visual acuity is a poor indicator of the existence of a refractive error in children, especially in cases of hyperopia because of the large accommodative reserve making it possible to compensate for the refractive error but at the cost of symptoms such as headaches, photophobia, etc. Indeed, after correction under cycloplegia, 90% of our sample had visual acuity between 8/10th and 10/10th. Compared with the percentage of visual acuity without correction, correction under cycloplegia made it possible to obtain a better result, hence the importance of the use of cycloplegic in the management of ametropia, especially in young subjects.

This observation allowed us to confirm that cycloplegia causes significant variations in the spherical equivalent going from myopia to hyperopia. These variations represent an indicator of variations in accommodation. The determination of refraction without cycloplegia is therefore not reliable, it tends to underestimate hyperopia and overestimate myopia. On the other hand, cycloplegia by relaxing accommodation allows the value of refraction to be measured more precisely [13-15]. As for the subjectively adjusted optical correction after cycloplegia in spherical equivalent, it revealed 24% myopia, 72% hyperopia and 4% emmetropia. These results are superimposable to those of the objective measurement of refraction under cycloplegia because only cycloplegia allows the objective study of refraction as well as the implementation of total optical compensation [16]. Furthermore, the spherical equivalent of the refraction, which corresponds to the algebraic sum of the power of the sphere and half of the power of the cylinder, can be considerably influenced by the sign of the cylinder in the case of very significant astigmatism compared to the sphere of opposite sign. In real values and regarding the refractive error observed before cycloplegia, astigmatism, all forms combined, was the most frequent refractive anomaly with 64%, especially in its compound form. Simple and compound myopic astigmatism accounted for 4% and 42% respectively, we did not find hyperopic astigmatism, while mixed astigmatism accounted for 18%. Our results agree with those of He [17] and Jeddi [6]. After cycloplegia, astigmatism of all types remained the most common refractive error. The mixed form predominated with 68% while simple and compound astigmatism represented 4% and 8% respectively. This variation found both by Sounouvou [18] in Benin and Kawuma [19] in Uganda is explained by the large variation in the spherical component of myopic astigmatism composed of myopia towards hyperopia under the effect of cycloplegia. After optical correction under cycloplegia, 48% of astigmatism of all types were observed, the majority of which was weak astigmatism with 40% of cases. This stability of astigmatism can be explained by the fact that it is essentially corneal and would therefore not have been influenced by cycloplegia which essentially affects accommodation and therefore at best on lens astigmatism [13,20]. Regarding hyperopia before cycloplegia, it represented 8% of ametropia. After cycloplegia, 16% of cases had hyperopia. Our results do not agree with several authors. Kouassi [9] and Jeddi [6] respectively found 67.32% and 67.1% hyperopia in their studies. We believe that in our study, these results could be explained by insufficient cycloplegia, which may result in an underestimation of hyperopia. However, after optical correction adjusted under cycloplegia, hyperopia was the most common refractive anomaly and its frequency at 52% is then close to the values of the previously cited authors [6,9]. This observation can be explained by the time elapsed between the objective measurement of the refraction and the actual realization of the optical correction. This delay would allow a strengthening of the action of the cycloplegic on the ciliary muscle and the better relaxation of accommodation. Under these conditions, a protocol in which the objective measurement of refraction from the sixtieth minute would allow a more reliable measurement of the refractive error. Myopia before cycloplegia represented 26% of refractive errors. After cycloplegia, we did not find myopia, nor to the extent objective nor the adjusted correction, in real values. These results could be explained by the fact that the effect of the cycloplegic makes it possible to determine true myopes, on the one hand and that on the other hand, the child's eye being small, it is anatomically predisposed to being hyperopic.

Conclusion

Uncorrected refractive errors are a significant cause of visual impairment in developing countries. Insufficient resources and the absence, sometimes, of health coverage for the majority in these countries could be the cause of non-systematic use of cycloplegia by certain health professionals. Such an attitude would be a serious error because it would provide a poor solution to the problem of uncorrected refractive errors by substituting the poor correction of these for their absence of correction. Failing to be systematic, optical correction under cycloplegia should be the rule whenever a drop in visual acuity in a child is accompanied by suggestive but non-specific symptoms such as headaches, eye pain, photophobia that no irritation of the ocular surface can explain. The approach should be the same in cases of “normal” distance visual acuity on visual acuity scales but with painful symptoms both in children and in adults up to the age of 45.

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