Assessment of the Utility of Plusoptix A09 Handheld Photo-refractometer in Screening Refractory Errors and Amblyopia in Children

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Abstract

The aim of this study is to find out the frequency of anisometropic amblyopia in children and to increase awareness about this disease. All children between the ages of 4 and 10 years who were attending 11 kindergarten and primary schools determined by provincial directorate for national education in the center of Malatya were included. A screening team including interns and a resident from the Department of Pediatrics have used Plusoptix A09 handheld photo-refractometer device for detecting amblyopia and its reasons. A total of 7,000 students were screened. The mean age of the students was 7.4 ± 2 years. Amblyopia was suspected in 357 cases with the Plusoptix S09 screening. After eye examinations performed by an ophthalmologist, 303 cases were found to have pathologic eye examination. Amblyopia was found in 67 (18.8%) of the 303 cases, and anisometropic amblyopia was found in 59 of 67 cases. As a result of the screening, sensitivity of Plusoptix A09 was found to be 88.1%, while its specificity was found to be 88.6%. Its positive predictive value was found to be 64.0% and its negative predictive value was found to be 97.0%. We believe that with screenings performed by health professionals who are given short-term training by using a device that can conduct remote measurements, detection of anisometropic amblyopia, which is the most frequent reason for amblyopia, can be done in a fast and relatively less expensive way and with the minimum number of specialist physician required. This way, children with amblyopia can reach the ophthalmologist earlier for treatment.

Keywords
► screening
► amblyopia
► photo-refractometer

Introduction

Amblyopia is defined as reduced corrected visual acuity following eye examination with no organic reasons. The global incidence of amblyopia is indicated as 1 to 4%.[1] In studies conducted in Turkey, the incidence of amblyopia is found to differ between 1 and 2.9%.[2–5] The most common reasons for amblyopia are anisometropia and strabismus.[6,7] Anisometropia is defined as the difference in refractive error between the two eyes, and further difference increases the risk of amblyopia.[8] In addition, it has been reported that the possibility of developing amblyopia is 14.7 times higher in patients with strabismus when compared with the normal population.[9]

Common goals in amblyopia treatments are to increase vision in the eye with amblyopia, enable a clear image in the retina, organize the ocular dominance, provide equal visual acuity in both eyes, provide alternate fixation pattern in

patients with strabismus, provide equal accommodation in both eyes, and enable both eyes to reach equal speed of reading.[10,11] While the response to treatment is the highest in cases whose treatments are started in the first 5 years of life, the response to treatment decreases gradually as the age increases up to 10 years.[6]

The aim of our study is to find out the sensitivity and specificity of Plusoptix A09 (Plusoptix GmbH, Nuremberg, Germany) in the detection of anisometropic amblyopia.

Material and Method

This study, which was conducted by İnönü University Turgut Özal Medical Centre's Department of Pediatrics and Department of Eye Diseases, was performed between March 2013 and February 2014. All children between the ages of 4 and 10 years who were attending 11 kindergarten and primary schools determined by provincial directorate for national education in the center of Malatya were included in the study. While choosing the schools in the study group, care was taken to choose schools that could represent the central district in which children from an average sociocultural level attended.

In our study, Plusoptix A09, a small, easy-to-apply, handheld photo-refractometer consisting of an infrared camera that can measure in a portable way and that can be connected to a computer screen was used.

The research was funded by Research Projects Unit with the project number 2012/151. A screening team was prepared consisting of medical faculty interns and a resident from the Department of Pediatrics, who were given a short training program on the use of Plusoptix A09 (►Fig. 1) handheld photo-refractometer device, which was bought with this fund, to detect amblyopia and its reasons.

The measurements were made in a darkened environment with at least three repetitions. Those children who were found to have more than ± 2.00-diopter myopia, hypermetropia, or astigmatism in both eyes were recorded with a risk of low vision and those who were found to have more than ± 2.00-diopter refractive error between the two eyes were recorded with a risk

of amblyopia. Later, the families were reached through telephone from their numbers taken officially from the schools. This way, the children were referred to ophthalmologists in the ophthalmology polyclinics of Malatya State Hospital or İnönü University Medical Faculty, who were informed of the screening. On the other hand, those children who were found to have strabismus or eyelid ptosis and those children in whom the device could not measure the refractory pathologies were referred for more advanced examination.

The children were asked whether they had been examined by an ophthalmologist before. In addition, in some of the feedbacks obtained while informing the families, children who had been previously examined by an ophthalmologist for eye diseases were also included in the screening results. This way, the researchers wanted to find out both the sensitivity and specificity values of the device and also to have an idea about the incidence of amblyopia in the population and to what extent it can be detected without screening.

Statistical Analysis

Statistical analyses were conducted with SPSS 15.0 for Windows (Statistical Product and Service Solutions, Inc., Chicago, IL, USA) program. In the assessment of study data, in addition to descriptive statistical methods (mean, standard deviation), the Kolmogorov–Smirnov test was used to examine normal distribution. Chi-squared test was used for the assessment of categorical variables (Pearson's chi-squared test and Fisher's exact test were used when necessary). The results were assessed with 95% confidence interval and $p < 0.05$ significance level.

Ethical approval was obtained from the local ethical board of İnönü University for the study. Written consent was obtained from the children included in the study as well as from their parents.

Results

Of the 7,000 students who were screened, 3,481 (49.7%) were female, while 3,519 (50.3%) were male. The mean age of the
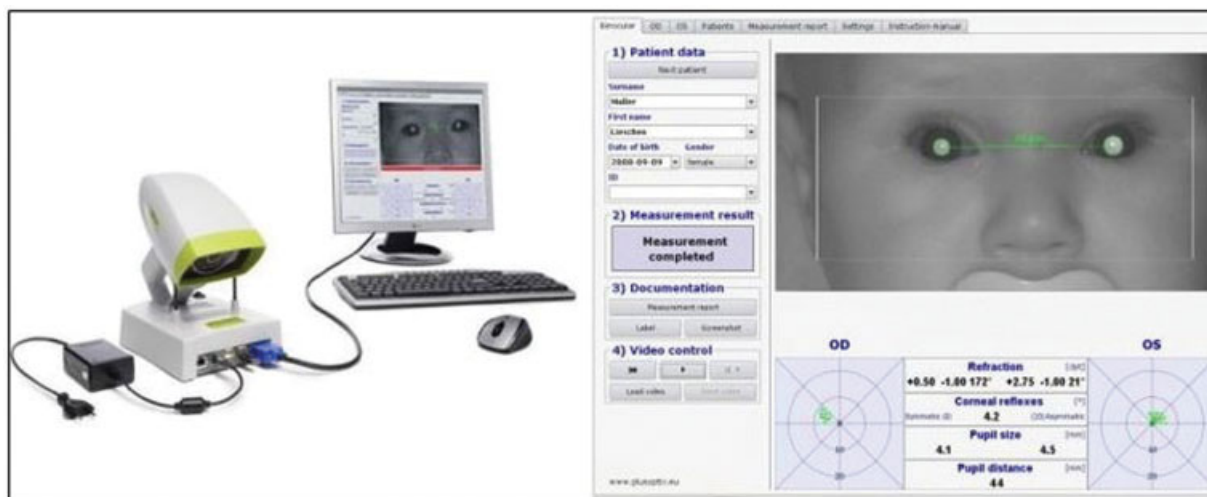

Fig. 1 The handheld photo-refractometer device used in the study and the image of working principles.

Table 1 The distributions of the children according to age and sex

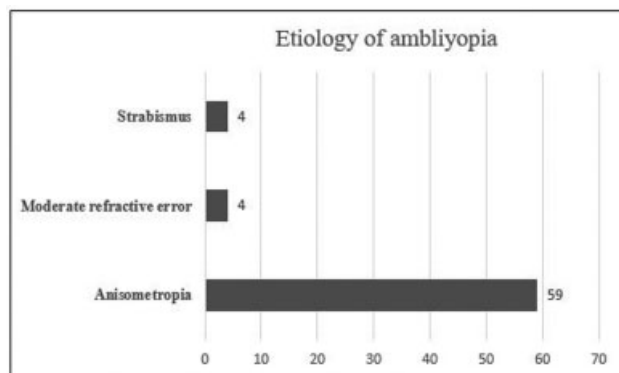| n (%)	4 years old	5 years old	6 years old	7 years old	8 years old	9 years old	10 years old	Total
Female	49 (1.41)	166 (4.77)	742 (21.32)	727 (20.88)	903 (5.94)	735 (21.11)	159 (4.57)	3.481 (49.7)
Male	78 (2.22)	202 (5.74)	788 (22.39)	747 (21.23)	900 (25.58)	650 (18.47)	154 (4.38)	3.519 (50.3)
Total	127 (1.81)	368 (5.26)	1.530 (21.86)	1.474 (21.06)	1803 (25.76)	1385 (19.79)	313 (4.47)	7.000 (100)

students was 7.4 ± 2 years. ►**Table 1** shows the distribution of the children in terms of age and gender. The mean age of the female participants was 7.03 ± 1.45 years, while mean age of the male participants was 6.81 ± 1.45 years. No difference was found between the ages of female and male participants ($p > 0.05$). Amblyopia was suspected in 357 cases as a result of the Plusoptix S09 screening, and they were sent to control eye examination performed by an ophthalmologist. After eye examinations, 54 (15.1%) cases were found to be normal, and 303 cases were found to have some ocular pathologies, namely, refractive errors in 239 cases and amblyopia in 67 (18.8%) cases. Anisometropic amblyopia was found in 59 of 67 cases and strabismic amblyopia was found in 4 children. On the other hand, amblyopia caused by moderate refractive error was observed in four children. Etiological distribution of the 67 cases that were found to have amblyopia is given in ►**Fig. 2**. Refractive errors found in children are summarized in ►**Table 2**.

No statistically significant difference was found between female and male children in terms of the incidence of refractive errors ($p = 0.8$).

Of the 7,000 children who were screened, 742 (%10.6) had previously been examined by an ophthalmologist. The number of students previously diagnosed with amblyopia was 23.

When 7,000 children who were screened between 4 and 10 years of age were assessed, we found the rate of amblyopia 0.9%, while the rate of refractive errors was 4.3%.

The sensitivity and specificity of Plusoptix A09 were found to be 88.1% and 88.6%, respectively, and its positive and negative predictive values were found to be 64.0 and 97.0%, respectively.

Discussion

Amblyopia is a condition in which visual loss that develops can be permanent if not treated in early childhood, and its treatment is not possible in adulthood.[12,13] In our study, after screening, amblyopia rate was found to be 0.9%. In Turkey, the largest study for screening amblyopia and eye diseases has been conducted by Turaçli et al.[14] In their study, which was conducted on 23,810 kindergarten and primary education children, the prevalence of amblyopia was found to be 1.1%. Although the prevalence of amblyopia is reported to be between 0.2 and 5.3% in pediatric population in the world literature,[15–19] general opinion about the prevalence is that it differs between 1 and 4% in different age groups and populations.[1] In our study, this rate was found to be around 1%.

In most of the studies found in the literature, the most common reason for amblyopia was anisometropia.[19] Similar to the results of other studies, the most common reason for amblyopia was found to be anisometropia in our study. Although the treatment for amblyopia is more effective before the age of 7 or 8 years, which is the sensitive period, the chance of success is higher when the treatment is started before the age of 4 years for amblyopia that occurs as a result of microtropia or anisometropia. For this reason, early diagnosis is important.

Another important finding of our study is the result that the rate of children previously examined by an ophthalmologist is only 10.6%. We could not come across any study that showed the rate of primary education children who had undergone eye examination previously. In a study conducted in Mexico City, it

Fig. 2 Etiological distribution ambliyopia cases.

Table 2 The distributions of refractive errors in the children according to gender

Refractive errors	Female	Male	p-Value
Myopia, n (%)	21 (5.9)	31 (8.6)	>0.05
Hyperopia, n (%)	22 (6.1)	29 (8.2)	>0.05
Astigmatism, n (%)	23 (6.4)	33 (9.3)	>0.05
Hyperopia + astigmatism, n (%)	26 (7.2)	30 (8.5)	>0.05
Myopia + astigmatism, n (%)	11 (3)	10 (2.9)	>0.05
Total refractive errors, n (%)	103 (28.8)	133 (37.2)	0.8

was found that only 3.8% of the children had undergone eye examination previously.[20] Taking into consideration the low rate of having been examined previously in many countries, it may not be possible for a long time for many amblyopia cases to be diagnosed. This result should be considered as another reason why amblyopia should be screened.

When the answer for the question "What age group of children should be screened?" is researched, it can be seen that eye controls are made at very early ages, especially in developed countries. When we look at these countries, it can be seen that besides the examination of newborns and 6- and 12-month-olds, in whom cataract development and fundus pathologies are of more priority, it is recommended that anisometropic amblyopia screenings should be conducted at around 4 and 5 years of age.[21] However, the number of screened children between the ages of 4 and 5 years was very low in our study. For this reason, we believe that screening the children for anisometropic amblyopia between the ages of 4 and 7 years can be more suitable in general field screenings.

A great number of studies have stated that similar devices can be used in population screening[22–24]; in addition, in a study conducted about the sensitivity and specificity of Plusoptix A09 in finding out amblyopia risk depending on refractive errors, sensitivity was found to be 94.9%, while specificity was found to be 67.5%.[25] In our study, sensitivity of Plusoptix A09 was 88.1%, while its specificity was 88.6%, and its positive and negative predictive values were 64.0 and 97%, respectively. In light of these data, it can be said that Plusoptix A09 is suitable for use in anisometropic amblyopia screening.

In conclusion, we believe that amblyopia screening can be conducted with Plusoptix A09 or a similar handheld photo-refractometry device. Considering that the compulsory preschool education may start at 48th month in Turkey, we suggest that these screenings for children should start at the age of 4 years and should include children in the age group 4 to 7 years. Also, the existing protocol between the Ministry of Health and the Ministry of National Education included in a continuous screening program should be developed and made more effective.

Author Contributions

The contributions of the authors are as follows—concept: M. S. S. and C. Y.; design: C. Y. and S. D.; supervision: C. Y.; data collection and/or processing: M. S. S. and S. D.; analysis and/or interpretation: S. D. and M. S. S; literature review: M. S. S. and C. Y.; writing: M. S. S. and C. Y.; critical review: C. Y. and S. D.

Conflict of Interest
None declared.

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