Comparison Between the plusoptiX and MTI Photoscreeners

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Objective: Both the Medical Technology and Innovations (MTI) and plusoptiX photoscreeners are used to objectively screen for amblyogenic risk factors in children. The MTI has been extensively studied, but the limited availability of film may render it obsolete. We compared the MTI with the plusoptiX, a newer digital photoscreener, for the ability to detect amblyogenic factors when compared with a comprehensive pediatric ophthalmic examination. We believe our results will help to guide community-based vision screening programs.

Methods: One hundred fifty-one children were examined consecutively in our office. Each patient was screened with the MTI and plusoptiX devices on the same day as part of a comprehensive pediatric ophthalmic examination. Results via MTI were evaluated by an expert masked examiner (R.W.A.), and the plusoptiX results were interpreted by the incorporated software.

Results: Sixty-five percent of patients were found to have amblyopia or amblyogenic risk factors during the pediatric ophthalmic examination conducted via the American Association of Pediatric Ophthalmology and Strabismus referral criteria. We found the MTI photoscreener to have a sensitivity of 83.6%, specificity of 90.5%, false-positive rate of 9.4%, false-negative rate of 16.3%, and positive predictive value of 94.2%. The plusoptiX demonstrated a sensitivity of 98.9%, specificity of 96.1%, false-positive rate of 3.7%, false-negative rate of 1.0%, and positive predictive value of 97.9%.

Conclusion: The MTI and plusoptiX photoscreeners proved to be effective when compared with a comprehensive cycloplegic pediatric ophthalmic examination. The plusoptiX, however, was found to have a higher sensitivity and specificity than the MTI.

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Pediatric vision screening has become an increasingly important topic in the United States, owing to the recent push in many states to mandate comprehensive eye examinations for all children at many different ages. Additionally, with the recent valuation of code 99174 at 0.69 relative value units by the Center for Medicare and Medicaid Services, it will now be possible for primary care providers and others to be reimbursed for screening children for amblyopia with a photoscreening device. Owing to these factors, validation of objective vision screening devices designed to effectively detect ocular disease in children and comparison of newer devices to older ones becomes critically important.

Vision screening can be performed via subjective and objective testing methods. Subjective testing (acuity testing via eye chart) requires a high degree of cooperation from the patient, which effectively places a lower limit on the age at which a child can be tested. This is antithetical to the goal of vision screening, ie, to detect problems as early as possible. Photoscreening has proven to be an effective method of objective screening. It may outperform traditional acuity testing by pediatric nurses and school nurses. Because much less cooperation from the child is required, even preverbal children can be reliably evaluated. Very early community photoscreening can lead to better treatment outcomes.

Detection of amblyopia or amblyogenic risk factors and treatment of amblyopia at the earliest age possible has been widely advocated. Although a recent study by the Pediatric Eye Disease Investigator Group has shown that treatment of children with amblyopia at an older age is possible, few would interpret this finding as a reason to delay screenings. Evidence clearly confirms that the effort and time required to treat amblyopia increases with
The long-term outcome of the original amblyopia treatment study by that group suggests that earlier initiation of amblyopia therapy, ie, before age 5, yields better acuity.

Other studies have shown that not all children referred to a specialist from a screening receive follow-up care. In one study only 50% of such children received a comprehensive eye examination. This result occurred owing partly to the fact that some parents, despite awareness of a problem, preferred to wait in hope that the detected problem might spontaneously resolve itself. Early detection and repeated failed vision screenings may be a useful tool to motivate parents to see a comprehensive pediatric ophthalmic examination. Pediatric vision screening with proper follow-up and treatment by a pediatric ophthalmologist is a proven and well-accepted method of discovery, treatment, and prevention of amblyopia in children.

We have had experience with the use of the Medical Technology and Innovations (MTI) photoscreener (Photoscreener Inc, Lancaster, Pennsylvania) for the past 13 years and with the plusoptiX S04 photoscreener (Plusoptix GmbH, Nuremberg, Germany) for the past 2 years. In well-established programs, the MTI device has been shown to be effective and reliable. In one study21 it was found to be more time-effective and to have a higher positive predictive rate than traditional screening methods. Results with the plusoptiX, obtained by 3 of us (N.S.M., E.L.S., and D.I.S.), have been published previously. In this study we compare results of the plusoptiX to the MTI photoscreener. The MTI device has been marketed to screening programs for more than 10 years. It has been studied extensively and has been the criterion standard for photoscreening. With the recent bankruptcy and reorganization of the Polaroid corporation (Minnetonka, Minnesota), the film for the MTI photoscreener has become extremely difficult to obtain, which has forced many vision screening programs to abandon the use of the device. We felt it important to establish a benchmark for the plusoptiX, a new third-generation digital photoscreener, in comparison with the MTI photoscreener before lack of film availability and lack of expertise for interpretation of the images makes it impossible to do so.

### METHODS

Before starting this research, we received approval through the institutional review board of Lancaster General Hospital. We received a waiver of consent owing to the low-risk nature of this research. We followed the appropriate guidelines of the 1996 Health Insurance Portability and Accountability Act.

One hundred fifty-one consecutive patients were examined without any bias to their diagnosis. All patients had photoscreenings via MTI and plusoptiX and a comprehensive pediatric ophthalmic examination on the same day. The plusoptiX and MTI photoscreenings were performed by an ophthalmic technician or a certified orthoptist. A cycloplegic refraction by means of cyclopentolate hydrochloride 1% was performed that same day or had been performed within the past 6 months by the same pediatric ophthalmologist. Pass/fail criteria for our examinations were determined in accordance with the American Association of Pediatric Ophthalmology and Strabismus (AAPOS) criteria. The results of an examination were counted as “fail” if the patient had ≥1 mm of anisocoria or any of the following were found:

- anisometropia (spherical or cylindrical) >1.5 D
- any manifest strabismus
- hyperopia >3.5 D in any meridian
- myopia magnitude >3.0 D in any meridian
- any media opacity >1 mm in size
- astigmatism >1.5 D at 90° or 180° >1.0 D in the oblique axis (>10° eccentric to 90° or 180°)
- ptosis ≤1 mm margin reflex distance
- visual acuity per age-appropriate standards

The MTI photoscreener is an off-axis, eccentric photoscreener that uses instant film to take 2 photographic images of the eyes of a patient; the 2 images print on one large instant photograph, which must be manually interpreted. In our study the MTI photographs were each marked with a unique patient identification number and mailed to one of the authors (R.W.A.) for analysis. This author, an acknowledged expert with regard to MTI photoscreening, has published 20 papers on the topic of photoscreening and has personally reviewed more than 30,000 MTI images. He uses the “delta center crescent” simplified interpretation method that compares very favorably in real-community screening. He was given no information that pertained to the patient except that which could be seen on the MTI printout. When 2 images could not be obtained from a patient in the initial photograph or the patient had not been looking at the camera, a second set of images was obtained and submitted with the first set.

The plusoptiX S04 is a third-generation, digital photoscreening device. Like the MTI, it is noninvasive, and testing is performed approximately 1 meter from the patient. The plusoptiX takes a video of the patient by means of an infrared video recorder linked to a laptop. Software is included so the user can analyze the data instantly. Referral criteria can be changed by the user to suit the patterns of his or her practice. In the plusoptiX vision screening, certain examination results were considered to have failed via modified referral criteria (Table 1). These modified criteria were previously shown to increase specificity with no chance in sensitivity.

### Table 1. plusoptiX Referral Criteria

<table>
<thead>
<tr>
<th>Age, mo</th>
<th>Anisometropia, D</th>
<th>Astigmatism, D</th>
<th>Myopia, D</th>
<th>Hyperopia, D</th>
<th>Anisocoria, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12</td>
<td>≥1.25</td>
<td>≥1.00</td>
<td>≥2.00</td>
<td>≥3.00</td>
<td>≥1</td>
</tr>
<tr>
<td>12-36</td>
<td>≥1.25</td>
<td>≥1.00</td>
<td>≥2.00</td>
<td>≥1.25</td>
<td>≥1</td>
</tr>
<tr>
<td>36-72</td>
<td>≥1.25</td>
<td>≥1.00</td>
<td>≥1.00</td>
<td>≥1.25</td>
<td>≥1</td>
</tr>
<tr>
<td>72-240</td>
<td>≥1.25</td>
<td>≥1.25</td>
<td>≥1.00</td>
<td>≥1.00</td>
<td>≥1</td>
</tr>
</tbody>
</table>

Abbreviation: D, diopters.
RESULTS

One hundred fifty-one patients were examined. Sixty-five percent of the pediatric ophthalmic examinations failed via the AAPOS referral criteria (with a prescreening probability of 65.2%). Of these, 48.9% of results failed the examination owing to significant refractive error. Of the patients from whom these failed results were derived, 11.2% were found to have strabismus, 28.3% had a combination of significant refractive error and strabismus, and 11.2% had other conditions, such as visually significant ptosis, anisocoria, and congenital cataract, which caused the results. Ages ranged from 6 months to 12 years.

The MTI device was found to have a sensitivity of 83.6%, specificity of 90.5%, false-positive rate of 9.4%, false-negative rate of 16.3%, and positive predictive value of 65.2%). Of these, 48.9% of results failed the examination owing to significant refractive error. Of the patients from whom these failed results were derived, 11.2% were found to have strabismus, 28.3% had a combination of significant refractive error and strabismus, and 11.2% had other conditions, such as visually significant ptosis, anisocoria, and congenital cataract, which caused the results. Ages ranged from 6 months to 12 years.

The plusoptiX was found to have a sensitivity of 98.9%, specificity of 96.1%, false-positive rate of 3.7%, false-negative rate of 1.0%, and positive predictive value of 97.9%. Only 1 patient had results that failed the pediatric ophthalmic examination but passed via the plusoptiX vision screening. That patient had a small angle esotropia and no significant refractive error (Table 2). Results from this patient failed the MTI photoscreening.

Table 2. Detailed Findings With Regard to False Negatives (FN) and False Positives (FP)

As new methods of pediatric vision screening become available, it is critically important to compare their validity to that of existing technology. Many variables, such as the population size, age range, and setting in which the testing is conducted, will have an effect on the choice of screening device. Photoscreening is a quick, inexpensive method for detection of amblyogenic factors in children.11,19 It has proven to be much quicker than subjective screening of acuity in young children and developmentally delayed individuals.6,20,21

As with any device, there are some disadvantages to the MTI. Its analog technology is widely considered to be antiquated. Although the device works well, it is self contained, and has proven to be solid and reliable over the years.

Figure 1. Comparative data between Medical Technology and Innovations (MTI) and plusoptiX photoscanners.
Vision Screening Certificate

Vision screening must be conducted regardless of any eye change over time.

Vision screening does not replace a complete eye examination by an ophthalmic or optometric practitioner.

OD
OS
Refractive Error
2.00 D
2.00 D
Pupil Size
7.2 mm
7.2 mm
Pass/Refer Criteria
All measurements were completed successfully.

- The difference between the refraction values of each eye is less than 1.25 D.
- The spherical equivalent of each eye is less than 1.25 D.
- The refraction values of each eye are between 1.00 and ±1.50 D.
- The difference between the refraction of each eye is less than 1.00 D.

Yes
No

2006-05-19

2001-01-01

Screening performed by:
David S. Albert, M.D., F.A.A.P. Vision Associates
2135 Hanesville Pike
Lancaster, PA 17601
717-399-7182

Figure 2. Example of plusoptiX report.

years, Polaroid no longer makes film for the camera, and it is unclear how long Fuji Film Holdings Corporation (Tokyo, Japan), the current supplier, will continue to do so. The camera manufacturer currently offers neither a digital model nor a digital retrofit to the existing model. With regard to the MTI photoscreeener, owing to the delay in the development of the film, the screening process takes longer because each photo needs to be assessed for adequacy of focus, pupil size, and fixation. This method is user dependent and requires expertise. The plusoptiX rapidly takes a succession of photographs and will not give a reading unless the images are adequate for computer analysis, qualities which markedly speed the screening process. With the MTI, there is usually a delay in interpretation of the results because most vision screening programs analyze the images off-site. There is also a risk of data loss and mislabeling of the images.

The plusoptiX device offers immediate results, printed out in an informative report (Figure 2). Large boxes, each with a green check mark or a red X inside, clearly show the parents why data from their child passed or failed the screening. Our study also suggests that the plusoptiX has better predictive value than the MTI photoscreeener. Finally, the plusoptiX device can directly interface with an electronic medical records system so that the data output can be entered into the chart immediately upon acquisition. It should be noted that clinical studies of screening devices in populations with a higher percentage of disease can overestimate false-negative rates and underestimate false positives. The advantage of both devices is that referral criteria can be individually modified by a screening program to reflect individualized populations and circumstances found in the community.

The AAPOS referral criteria is a consensus criteria as to what level of refractive error, ptosis, strabismus, etc., should be detected by a screening device, as this data is felt to have a high correlation with amblyopia in children. The criteria is not meant to be plugged directly into electronic screening devices, but instead is used to grade the device results when compared with a criterion-standard pediatric ophthalmic examination with cycloplegia. One would expect the referral criteria entered into the plusoptiX, especially hyperopia, to be different than that for cycloplegic refraction. The plusoptiX testing, which is performed for undilated eyes at a distance of 1 meter, encourages accommodation.

We believe that the plusoptiX and MTI systems are effective screening tools and recognize that the plusoptiX system has advantages that may allow it to replace the MTI system. Objective vision screening devices are critically important as we move toward the goal of universal vision screening for children. As screening devices become easier to use, more reliable, and less expensive, we will be able to recognize those children in need of referral to a pediatric ophthalmologist, which will eliminate time-consuming and expensive mandated comprehensive eye examinations. It should be mentioned that there is currently no proof that mandated universal comprehensive eye examinations are more effective than vision screening followed by comprehensive pediatric eye examinations for children whose results fail screenings. Conversely, mandated comprehensive eye examinations have been shown to be far more costly than vision screening followed by comprehensive pediatric eye examination of those children whose results fail vision screenings. There is currently a shortage of pediatric eye care providers with the expertise necessary to successfully satisfy a mandate that requires comprehensive eye examinations. In light of this fact, objective vision screening takes on added importance. As instant film technology now requires replacement, the validated MTI photoscreeening is not being replaced by an inferior digitally interpreted alternative, but rather by one capable of even greater validity.

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REFERENCES


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