Comparison Between the plusoptiX and MTI Photoscreeners

Noelle S. Matta, CO, CRC, COT; Robert W. Arnold, MD; Eric L. Singman, MD, PhD; David I. Silbert, MD

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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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 seek 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 study 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 were 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 change 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.
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%, the results. Ages ranged from 6 months to 12 years.

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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, is self contained, and has proven to be solid and reliable over the years, there are some limitations to its use, particularly in younger children. The MTI photoscreener is limited in its ability to detect amblyogenic factors in young children, as it is not able to accurately measure refractions in children under the age of 6 years. Additionally, the MTI is not as sensitive as newer devices, such as the plusoptiX, which has a sensitivity of 98.9%, specificity of 96.1%, false-positive rate of 3.7%, and false-negative rate of 1.0%.

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

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

<table>
<thead>
<tr>
<th>Refraction OD</th>
<th>Refraction OS</th>
<th>Examination Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>plusoptiX FN</td>
<td>+1.75 +1.00 × 005</td>
<td>LET 10, amblyopia</td>
</tr>
<tr>
<td>plusoptiX FP</td>
<td>+0.75 sph</td>
<td>Normal results: plusoptiX unable to obtain reading</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−0.25 sph</td>
<td>Normal results: plusoptiX unable to obtain reading</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+1.25 sph</td>
<td>Visually significant ptosis</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−0.75 + 1.00 × 85</td>
<td>Anisometropia, amblyopia</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+1.50 +1.00 × 105</td>
<td>High astigmatism, amblyopia</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−2.00 + 3.50 × 180</td>
<td>Refractive amblyopia</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−0.75 + 2.75 × 105</td>
<td>Anisometropia, CN IV palsy</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−0.75 sph</td>
<td>Visually significant ptosis</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−2.00 + 2.00 × 95</td>
<td>Refractive amblyopia, RET 4</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−0.25 + 0.75 × 100</td>
<td>1.5-mm anisocoria</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+0.75 +0.25 × 90</td>
<td>Intermittent exotropia 4, poor control</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+3.75 sph</td>
<td>Refractive amblyopia</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−1.00 + 0.25 × 90</td>
<td>1-mm anisocoria</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+0.50 +1.25 × 95</td>
<td>High astigmatism</td>
</tr>
<tr>
<td>MTI FN</td>
<td>+1.25 + 1.75 × 10</td>
<td>High astigmatism</td>
</tr>
<tr>
<td>MTI FN</td>
<td>−1.50 + 0.50 × 180</td>
<td>NA</td>
</tr>
<tr>
<td>MTI FP</td>
<td>+1.00 sph</td>
<td>NA</td>
</tr>
<tr>
<td>MTI FP</td>
<td>+2.25 +0.75 × 90</td>
<td>NA</td>
</tr>
<tr>
<td>MTI FP</td>
<td>+0.25 +1.00 × 80</td>
<td>NA</td>
</tr>
<tr>
<td>MTI FP</td>
<td>+3.00 sph</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviations: CN IV, cranial nerve 4; LET, left estropia; NA, not available; Plano, 0.00 + 2.00 × 90; RET, right estropia; sph, sphere.
devices is that referral criteria can be individually modi-
and underestimate false positives. The advantage of both
percentage of disease can overestimate false-negative rates
alties on acquisition. It should be noted that clinical stud-
data output can be entered into the chart immedi-
terface with an electronic medical records system so that
screener. Finally, the plusoptiX device can directly in-
to the plusoptiX, especially hyperopia, to be different
place is critical as we move toward the goal of uni-
Bosk system has advantages that may allow it to replace
Objective vision screening devices are critically important as we move toward the goal of uni-
We believe that the plusoptiX and MTI systems are
effectiveness and recognition that the plusop-
vision screening followed by comprehensive pediatric eye
22,23 Conversely, mandated comprehensive eye ex-
held to have a high correlation with amblyopia in chil-
children. The criteria is not meant to be plugged directly into
electronic screening devices, but instead is used to grade
verse screening for children. As screening de-
become easier to use, more reliable, and less expen-
will be able to recognize those children in need of referral to a pediatric ophthalmologist, which will
will eliminate time-consuming and expensive mandated com-
care providers with the expertise necessary to success-
shortage of pediatric eye care providers with the expertise necessary to success-
reexamination of those children whose results fail vision
examinations for children whose results fail screen-
there is currently no proof that mandated universal comprehensive eye examinations are more effective than vi-
ning examinations followed by comprehensive pediatric eye
examinations for children whose results fail screen-
screening followed by comprehensive pediatric eye
examinations of those children whose results fail vision
examinations. In light of this fact, objective vision screen-
takes on added importance. As instant film technol-
ogy now requires replacement, the validated MTI pho-
toscreening is not being replaced by an inferior digitally
interpreted alternative, but rather by one capable of even
greater validity.

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Correspondence: Noelle S. Matta, CO, CRC, COT, Fam-
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Figure 2. Example of plusoptiX report.

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