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VALIDITY OF PHOTOSCREENER FOR ASSESSMENT OF STRABISMUS LESS THAN 40 PD IN CHILDREN LESS THAN 5 YRS OF AGE

KEYWORDS Hirschberg test, modified Krimsky, paediatric autorefractometer

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ABSTRACT

AIM: To measure the ocular deviation less than 40 PD in children less than 5 years of age with photoscreener and compare with Krimsky and Hirschberg method.

METHOD: A total of 446 children less than 5 years of age and degree of misalignment less than 40 PD were included in the study. Exclusion criteria was any misalignment above 40 PD. Measurement of ocular misalignment was done in all patients with Hirschberg method, Krimsky method and photoscreener (plusoptix A 09, GmbH, Germany). Time taken for the measurement of deviation was noted for each patient.

RESULT: There was no statistical significant difference between measurement of Krimsky and Plusoptix however both showed significant difference with the Hirschberg test. Time taken for measurement of ocular deviation with paediatric autorefractometer was comparable to Hirschberg test but significantly less as compared to time taken with Krimsky test as child cooperation is very important while measuring deviation.

CONCLUSION: Photoscreener is an effective tool for measurement of deviation below 40 PD and gives results comparable to Krimsky test. Since time required for measurement of deviation with photoscreener is much less as compared to Krimsky and requires less child cooperation hence it can be recommended for measurement of deviation less than 40 PD.

Introduction:

Strabismus is a common condition in childhood affecting 2-4% of the population, with an increased prevalence associated with low birth weight (including premature infants) or neuro-developmental disorders, maternal smoking and maternal illnesses in pregnancy.[1] There is a constant endeavour by various health authorities to screen the strabismus cases at the earliest and refer them for appropriate management. Different vision screening programs are increasingly using the photoscreeners to screen for amblyopia, refractive error and misalignment following the recommendations of the American Association of Paediatric Ophthalmology and Strabismus(AAPOS) in 2012. [2]

Traditional methods of screening for ocular misalignment involves either Hirschberg test(HBT) or modified Krimsky method, however both the methods are impractical, time consuming and can be highly inaccurate when examining children below 5 years particularly those who are uncooperative. This leads to gross under referrals by primary care physicians, orthoptists and even general ophthalmologists.[3-7] Photoscreener(plusoptiX) has proved useful tool for screening and detection of amblyogenic factors in children. This instrument also has the ability to detect manifest strabismus in uncooperative patients at a very rapid speed. Additionally its ease of use by even the novice has ensured its utility in various outreach screening programmes.[8,9] At our centre we utilized this instrument for assessment of strabismus less than 40 Prism Diopter and compared it to Hirschberg and Krimsky method.

Material and methods:

This was a prospective study conducted in the outpatient dept of Ophthalmology at a tertiary care set up from 1 Jan 2014 to 1 Jan 2016 where 446 patients of strabismus less than 40 Prism diopter (PD) were included in the study. Ethical clearance for the study was obtained from the institutional ethical review board. Written informed consent was taken from the parents of all the children who participated in the study. The Inclusion Criteria for the study was children less than 5 years, degree of misalignment was less than 40 PD. Exclusion criteria was any misalignment above 40 PD. Detailed history was taken from parents regarding duration of deviation, fixation preference. Detailed squint work up was done which included retinoscopy, Interpupillary distance, Ocular movements, any associated dissociated vertical deviation, inferior oblique overaction, latent nystagmus, fixation preference and anterior and posterior segment examination to rule out any associated congenital anomaly. Measurement of ocular misalignment was done in all patients with both Krimsky method and photoscreener (plusoptix A 09, GmbH, Germany). Time taken for the measurement of deviation was noted for each patient.

The methodology followed for Plusoptix A 09 photoscreener was standardized as follows. The photoscreener was held approximately 1.20 metres (3.3 feet) away from the child at eye level and the equipment activated by pressing once on the trigger in the handle. A warble sound drew the child's attention to the camera. The camera was moved slowly forwards till green circles were seen around both pupils and another warble sound was heard. The measurements are completed within one second. The measurement values were noted from the gaze charts and the average midpoint of these green or red point clouds was taken as final reading. Corneal reflexes appear as green point clouds (Fig 1).

The Hirschberg method was done by shining a penlight over the eyes in a semidark room. This test is based on the premise that 1 mm of decentration of the corneal light reflection corresponds to approximately 7°(15), of ocular deviation of the visual axis. Therefore, a light reflex at the pupillary margin is about 2 mm from the pupillary center (when the pupil is about 4 mm), which corresponds to 15°(30) of deviation. A reflex in the mid-iris region is about 4 mm from the pupillary center, which is around 30°(60) of deviation.

The Krimsky method was done by shining penlight over both corneas. Prisms were held before the fixating eye or split between the 2 eyes till centration of corneal reflex was achieved.

Data analysis:

The deviation measured in all the three groups was compiled alongwith the time taken for each test. Descriptive statistics were used to summarise the deviation data by calculating the numerical descriptors, including mean and standard deviation. Paired t-test was done between Hirschberg and Krimsky, Hirschberg and Plusoptix, Krimsky and Plusoptix. Pearson correlation coefficient was calculated for all three groups.

Results:
A prospective study was conducted in the outpatient department of Ophthalmology at a tertiary care set up from 1 Jan 2013 to 1 Jan 2016 where 446 patients of strabismus less than 40 Prism diopter (PD) were included in the study. Mean age of patients studied were 2.6 yrs.

We compared the ocular deviation measured by Krimsky, Hirschberg and with Plusoptix. Pair 1 between Krimsky and HBT revealed a mean difference of -0.39, t value of 5.793 and p value was <0.001(significant). Pair 2 between HBT and plusoptix with mean difference of 0.28 and p value of 0.034(significant). Pair 3 between Krimsky and Plusoptix showed a mean difference of -0.11 and a p value of 0.433(not significant).

We found that there was no statistical significant difference between Krimsky and Plusoptix however both differed from HBT measurements. Time taken for measurement of ocular deviation with paediatric autorefractometer was comparable to Hirschberg test but significantly less as compared to time taken with Krimsky test as child cooperation is very important while measuring deviation. Drawbacks of this method of measurement noted were limited to measuring deviation less than 40 Prism dioptre and cost factor compared to Krimsky and Hirschberg tests.

Discussion:
Measurement of strabismus using either Hirschberg, cover test, prism bar cover test and synoptophore is a mandatory requirement while planning the management strategy. In children under five years where the cooperation of the child is also not assured, the measurement of deviation becomes rather conjectural relying mostly on Hirschberg test. This leads to a large amount of miscalculation as the surgical dosage is dependant on the measurement of deviation. The Hirschberg test estimates the size of the strabismus by determining the deviation of central light reflex. The Krimsky test utilizes a prism to center the deviated light reflex and the amount of the prism which is needed to center the deviated light reflex estimates the size of the eye misalignment. Although light reflex testing is the least accurate way to measure strabismus however it may be the only means possible in young children.

The Hirschberg test commonly used for measurement of ocular deviation was introduced more than 120 years ago. By shining a penlight toward the patient's eyes, the displacement of the light reflex (first Purkinje image) from the center of the pupil can be observed, allowing an estimate of the amount of ocular misalignment. Originally, this displacement was described in terms of proximity of the corneal reflex to ocular landmarks (pupil, iris, limbus). This test has been modified to represent the ocular deviation in a more quantitative manner by multiplying the displacement of the light reflex by a simple proportionality constant, which expresses the ratio between ocular rotation and reflex displacement and is called the Hirschberg ratio (HR). It can be expressed in either degrees per millimeter or prism diopters per millimeter5 In a person with normal ocular alignment the light reflex lies slightly nasal from the center of the cornea (approximately 11 prism diopters or 0.5mm from the pupillary axis), as a result of the cornea acting as a temporally-turned convex mirror to the observer. [4-7]

Another method is Krimsky which requires attention and cooperation from the child to atleast focus straight for more than 20-30 sec while the examiner centers the reflex while holding prims of varying diopters. This method is the most accurate; but can give highly inconsistent results if the child is inattentive.[4]

Various studies have established beyond doubt that corrective surgery for strabismus depends on the measurement of the angle of ocular misalignment.[8,9] Standard tests for the measurement of strabismus, the prism bar cover test, cannot be carried out in infants and very young children, thus angle of deviation is often determined using the Hirschberg test or Krimsky test which gives variable results in differing situations. This wide variation in the test results can also lead to significant errors in surgical calculations and thus the final outcome.

Birch et al in 1998 and also the Early surgery for congenital esotropia trial (ESCET) had concluded that infants with constant esotropia of more than 40 PD and hyperopia less than 3.00 D are valid candidates for surgery.[10] It is the group of children with strabismus less than 40 PD which needs attention and follow up to look for spontaneous resolution or progression. Various studies have noted a high prevalence of neonatal strabismus, primarily exotropia which typically resolves without treatment, during the first two months. But strabismus within 40 PD with either no or mild refractive error poses a challenge to every ophthalmologist. In this regard accurate measurements on each follow up visit gives a fairly good estimate to plan the management.

Paediatric autorefractometer is mainly used for auto refraction in infants and very young children, however along with refraction it also provides various parameters like interpupillary distance, pupil size and strabismus measurement. In addition the acquisition time is 0.8 seconds, thus these features make it a very effective tool for gathering vision data on non-verbal, uncooperative patients. [[11-16]

A technology assessment of preschool vision screening by the Canadian Agency for Drugs and Technologies in Health (Dunfield and Keating, 2007) found that, with photoscreening, sensitivities ranged from 27.8 % to 88 %, and specificities ranged from 40 % to 98.5 % in different studies. The technology assessment found that no single test or group of tests has been shown to be superior for preschool vision screening. The Canadian Paediatric Society in 2009 published the guidelines substantiating the cost-effectiveness as well as the efficacy of photoscreening in preschoolers. They cited two major studies by Donahue, et al., 2006 and Arnold, et al., 2005 (sensitivity of 80 percent and 95 percent respectively). They cited the negative predictive value of photoscreeners which is yet to be studied and hence comparison with traditional methods is not possible.[17]

In a multi-center, randomized controlled study, Salcido et al (2005) compared the usefulness of traditional vision screening and photoscreening of 3- and 4-year-old children in the pediatrician's office. MTI PhotoScreener (Medical Technology Industries, LLC, Riviera Beach, FL) and traditional acuity and stereopsis screening materials (HOTV charts/Random Dot E tests) were assessed. A total of 605 children were screened with the photoscreener and 447 were screened with traditional techniques. Mean time for screening was less with the photoscreener: 2.5 versus 5.9 minutes (p < 0.01). Untestable rates were similar (18 % versus 10%, respectively p = NS), but higher with the photoscreener. Referral rates were also similar: 3.8 % versus 4.5 %. With follow-up results obtained from 56 % of referred children, 73 % of photoscreening referred children (8/11 examined) had amblyogenic factors confirmed on formal eye examinations, whereas all children referred using traditional screening methods (10/10 examined) were normal. These authors concluded that photoscreening is more time efficient than traditional screening and has a significantly higher PPV in 3- and 4-year-old children. However, this study was unable to validate traditional screening techniques in this pre-school age group.[18]

Teed et al in 2010 conducted a study on amblyopia screening and management in a community photoscreening program. Treatment regimens included spectacles, patching, and/or atropine penalization. Of 901 children evaluated after being referred from photoscreening, 551 had amblyopiogenic risk factors without amblyopia, 185 were diagnosed with amblyopia, and 165 were false-positives. Of 185 children with amblyopia, 125 met inclusion criteria for analysis and 78 % (97 of 125) were successfully treated. The authors concluded that the success rate of amblyopia treatment in children identified through the authors' photoscreening program is high. They noted that these findings support the role of photoscreening programs in the prevention of amblyopia-related vision loss. The drawbacks of this study included non-standardized VA measurements, variability in amblyopic treatment and uncertainty in the diagnosis and treatment of amblyopia in pre-literate children.[19]

Yanovitch and colleagues in 2010 determined the sensitivity, specificity, and positive and negative predictive values of photoscreening in detecting treatable ocular conditions in children with Down syndrome. Both the Medical Technology and Innovations [MTI] and Visiscreen OSS-C [VR] photoscreening devices had a sensitivity of 93 % (95 % confidence interval [CI]: 0.76 to 0.99) for detecting treatable ocular conditions. The specificities for the MTI and VR photoscreening were 0.35 (CI: 0.18 to 0.57) and 0.55 (CI: 0.34 to 0.74), respectively. The authors concluded that photoscreening is sensitive but less specific at detecting treatable ocular conditions in children with Down's.[20]

Though photoscreener also measures the ocular deviation as an added parameter yet no study has validated the amount of deviation and compared with Hirschberg and Krimsky.[21-24] Our study assessed the usefulness and precision of strabismus measurements of Pluosptix autorefractometer in our pediatric ophthalmology practice and compared with both Hirschberg and Krimsky methods. Our study concluded that the ocular deviation measured by Krimsky and Plusoptix are comparable. Limitation of the photoscreener is that it cannot measure deviations beyond 20 degrees or 40 PD.

We found that there was no statistical significant difference between Krimsky and Plusoptix however both differed from HBT measurements. Time taken for measurement of ocular deviation with paediatric autorefractometer was comparable to Hirschberg test but significantly less as compared to time taken with Krimsky test as child cooperation is very important while measuring deviation. Drawbacks of this method of measurement noted were limited to measuring deviation less than 40 Prism dioptre and cost factor compared to Krimsky and Hirschberg tests.

In addition to the ocular deviation measurement the paediatric autorefractometer also gives autorefraction, interpupillary distance and pupil size which we did not include in our study. All these parameters further increase the information acquired out of a single acquisition from the patient thus adding to the clinical expertise.

This study gives credence to the fact that objective quantification of deviation data in small uncooperative children will subsequently improve the outcome in children with strabismus. Also long term follow up such children will give an insight into the progression of strabismus with small deviation. Thus strabismus measurement and also its documentation in infants and young children can be done in a very short span of time as compared to Hirschberg test. As measurement is fully automated, it can be performed even by paramedical staff thus can be used in screening programmes also. In this study we found that ocular misalignment measurement with paediatric autorefractor was reliable and can be easily used for strabismus measurement and surgeries in children less than 5 years. However the drawback was that it cannot measure large angle squints thus limiting its application in strabismus measurements in children where most of the essential infantile esotropias are large angle usually more than 30 prism dioptres. Paedatric autorefractor can also be a useful tool for measurement of post operative results where slight undercorrection or overcorrection can be measured easily without any subjective bias where as it becomes difficult in Hirschberg test however further study has to be done to substantiate the same.

Conflicts of interest:
All authors have none to declare

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Legend for Figure1
Figure 1: Print out of photoscreener report showing deviation of 10 degrees(hypotropia) in left eye.

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