# Use of consumer digital camera for screening amblyogenic risk factors in children

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## Abstract:

Amblyopia is one of the major causes of childhood blindness. Screening of all pre-school children for refractive errors and strabismus is important to detect amblyopia and prevent a child from losing his/her eyesight permanently. We evaluated the efficacy of Canon Powershot SX-260 HS digital camera as an amblyopia screener for identifying amblyogenic risk factors. We obtained Bruckner reflex photographs using consumer digital camera. There were 77 subjects, 42 were amblyopes and 35 were diagnosed to be normal. Of the 42 subjects, 23(55%) were strabismic amblyopes and 19(45%) were anisometric amblyopes. Overall mean sensitivity of was 95% for all amblyopes, 82% for strabismic and 83% for anisometric amblyopes. The specificity was found to be 94% for all amblyopes, 87% for strabismic and 88% for anisometric amblyopes. The consumer digital camera appears to be a simple, quick and feasible option to screen for amblyogenic risk factors. It is easy to interpret by not only the ophthalmologists but by students and paramedical staff.

**Keywords:** Amblyopia, Childhood blindness, Digital camera, Strabismus, Anisometropia.

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## Introduction:

Childhood blindness is one of the priorities in Vision 2020; The Right to Sight (1). This program was launched for elimination of avoidable blindness. There are approximately 1.4 million blind children in the world; 2/3rd of them is present in developing countries. India has 407 million children below the age of 16 years. Though there are 200,000 blind children in India, pediatric ophthalmology is not yet well established (2).

Childhood blindness has an adverse effect on development and growth of children. Severe visual impairment and blindness in infants must be detected early for immediate management to prevent amblyopia. Very few studies have been done in India to estimate prevalence of childhood blindness. The available data suggests that one out of every thousand children is blind, therefore there is need to develop skills for early detection of avoidable blindness in children. Amblyopia is due to childhood strabismus, media opacities and anisometropia (3). It is a preventable cause of childhood blindness with appropriate timely interventions (4).

The Bruckner test (BT) is a low cost, simple and quick method to detect amblyogenic risk factors among children (3). BT looks for significant refractive error,

strabismus of 4 or more prism diopters, anisometropia of 1 diopter or more, media opacity, and afferent pupillary defect. It relies on comparison of brightness and pattern of trans pupillary reflex by a trained examiner using a direct ophthalmoscope.

By utilizing the Bruckner's reflex with Consumer Digital Camera (CDC), the screening becomes simple, acceptable, portable and efficient. The child friendly CDC can record light crescent in the pupil of ametropic eye and brighter reflex in strabismic (5,6).

Hence the present study was designed to assess the utility of CDC in diagnosing amblyogenic risk factors in children.

**Material and Methods**:

A hospital based cross-sectional study was performed on pediatric patients attending eye OPD between April and May 2014 .All the patients below 16 years of age, either sex, irrespective of presence of amblyopia were included. Amblyopes were patients having either hyperopia, myopia, strabismus or media opacities. Patients with poor medical condition (illness), trauma, comatose and unwilling to participate were excluded from the study. The written informed consent was taken from all the parents willing to participate in the

study after Institutional Ethics Committee (IEC) approval.

Canon Powershot SX-260 HS digital camera (Figure I) was used to elicit the bruckner's reflex. Patients were photographed from five-feet, seated on a chair in primary gaze in a dim room (such that newsprint could be read with difficulty). With the aid of 10X optical zoom, flash photographs with bilateral red reflex were recorded.

The photographs were transferred to a laptop, cropped and coded. 3 compact discs (CDs) were made, with randomly arranged photographs. A separate CD of model photographs containing: Normal, Strabismic and anisometropic, red reflex generated by CDC was made to train the observers. The photographs were categorised as 'Normal' / 'Emmetropia' if symmetrical red glow of both eyes, 'Hyperopia' if upper crescents noted in pupil, 'Myopia' if lower crescents noted, 'Strabismic' if brighter red reflex in one eye and 'Anisometric' if asymmetric red reflex. (Figure II) The photographs were observed by the Principal Investigator, Medical Student and two more independent observers and their predicted diagnosis was recorded.



**Figure I**: The Canon Power Shot – SX 260 HS used in the study



**Figure II** : **A)** Symmentrical red glow of both eyes in a normal subject **B)** Upper Crescents : Hyperopia **C)** Lower Crescents : Myopia **D)** Asymmetric red glow in the two eyes : Anisometropia **E)** Brighter red reflex in one eye : Strabismus

The guide (Paediatric Ophthalmologist) was blinded to the above results of the above photographs. He performed the comprehensive eye examination of all the participants. Visual acuity was assessed by CSM (Central, Steady and Maintained), Lea symbols and ETDRS chart. Anterior segment examination was done by torch light and slit-lamp examination. Fundus evaluation was done by indirect ophthalmoscopy (+20D). He also performed cycloplegic refraction (Cyclopentolate / Tropicacyl Plus) and detailed squint examination.

The predicted diagnosis reached by observing the photographs was correlated with ocular examination findings done by the guide on every case.

**Statistical analysis:**

For analyses the subjects were categorised into 3 groups: All amblyopes, Strabismic amblyopes and Anisometric Amblyopes. Diagnostic indices: Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, Positive Likelihood Ratio and Negative Likelihood Ratio were subsequently calculated by using Statistical Package for the Social Sciences (SPSS) (V-12) and JavaStat.

**Results:**

During the study period we reached a sample size of 77 subjects. There were 39 (51%) males and 38(49%) females. Out of the total subjects, 35(45%) were normal or with insignificant anisometropia and 42 (55%) were identified as amblyopes. Among the 42 identified as amblyopes, 23(55%) were strabismic amblyopes and 19(45%) were anisometric amblyopes. The mean age was 11.73 years in normal subjects, 11.81 years in strabismic and 11.77 years in anisometric group. The baseline characters are shown in Table 1.

**Table 1**: Demographics and baseline characteristics

| | | Amblyopia | |
| | Normal (n=35) | Strabismic (n=23) | Anisometropic (n=19) |
|---|---|---|---|
| Mean age (in yrs) | 11.73 (3.05) | 11.81 (3.03) | 11.77 (3.10) |
| Gender | | | |
| Male | 17 (22%) | 11 (14.2%) | 11 (14.2%) |
| Female | 18 (23.3%) | 12 (15.5%) | 8 (10.3%) |
| BCVA RE Mean ± SD | 0.01 (0.05) | 0.45 (0.26) | 0.45 (0.26) |
| BCVA LE Mean ± SD | 0.01 (0.05) | 0.45 (0.26) | 0.45 (0.25) |

BCVA:Best corrected visual acuity; RE: right eye; LE: left eye

Diagnostic indices (Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, Positive Likelihood Ratio and Negative Likelihood Ratio) used in the study are shown in Table 2.

**Table 2:** Groupwise analysis of diagnostic indices

| | All amblyopes | Strabismic amblyopes | Anisometropic amblyopes |
|---|---|---|---|
| Sensitivity | 0.95 | 0.82 | 0.83 |
| Specificity | 0.94 | 0.87 | 0.88 |
| Positive Predictive value (PPV) | 0.95 | 0.73 | 0.68 |
| Negative Predictive Value (NPV) | 0.94 | 92.16 | 0.94 |
| Positive likelihood ratio | 0.05 | 6.37 | 7.02 |
| Negative likelihood ratio | 16.67 | 0.2 | 0.19 |

The sensitivity of CDC generated Bruckner Test was 95% for all amblyopes, 82% for strabismic and 83% for anisometric amblyopes. The specificity was found to be 94% for all amblyopes, 87% for strabismic and 88% for anisometric amblyopes.

**Discussion:**

Amblyopia is one of the major avoidable factors in childhood blindness. Medical Technology Inc (MTI) Photoscreeners, Nikon Retinomax hand held autorefractors, Bruckners Test and modified Bruckners Test were used in the past to detect amblyopia (7-11). Assessment of visual acuity helps to detect amblyopia while the corneal light reflex test and the cover test helps in detecting strabismus (12). The incidence in those below 20 years of age is 10 times more frequent than all other diseases including trauma (13). In spite of voluminous literature, studies performed by various authors vary widely with respect to the protocols, tests utilised, referral criteria and personnel performing the screening, hence one to one comparison is difficult.

The standard Bruckners Test (BT) is done with a direct ophthalmoscope and the brightness pattern of transpupillary reflex is noted. It is simple, low-cost, quick and hence extensively used to identify anisometropia and strabismus. Since it is an objective test it can be used even for preverbal children and those uncooperative with alternate cover testing. Kothari et al used BT to detect ARF and reported sensitivity of 87.5% and specificity of 84.1% (5). However the test has certain limitations. Quantification of the results is one of the major drawbacks. Apart from the need of a skilled examiner

it also possesses inter-observer and intra-observer variations. Later, another study done by him found sensitivity and specificity of 91% and 72.8% using the BT (10).

Medical Technology and Innovation (MTI) photo-screener was used by Ottar which reported a sensitivity of 81.8% and specificity of 90.6%. They claimed to have detected all cases of strabismus with MTI (7). Retinomax NCR was used by Barry and Konig for screening of amblyogenic anisometropia and reported sensitivity and specificity of 80% and 58% for >1.5DC or >1D anisometropia, and 70% and 60% for 2.0 DC or 1.5D anisometropia (8).

In the present study, we used consumer digital camera (CDC) for eliciting bruckners reflex to screen for amblyogenic risk factors (ARF). In this way, the screening became simple and quick. It also eliminated the need of a skilled examiner while being efficient at the same time. An identical study using digital camera was performed by Sadat et al and reported the sensitivity and specificity of 86% and 85% (6). We found sensitivity and specificity of 95% and 94% which was comparable to the previously published study in the literature. Further our test produced sensitivity and specificity for strabismic amblyopia to be 82% and 87% respectively whereas sensitivity and specificityof anisometric amblyopia was 83% and 88%.

Amitava used Modified Bruckners Test (MBT) using the streak retinoscope instead of direct ophthalmoscope.He found sensitivity and specificity of 57% and 97% for anisometropia of 0.5D, 74% and 95% for anisometropia of 1D.He also reported sensitivity and specificity of 50% and 98% for strabismic amblyopia. This established that MBT was accurate and useful for detecting ARF (11). Lea Symbols and HOTV recognised amblyopia with sensitivities of 0.65 (95% CI: 0.54-0.76) and 0.52(95% CI: 0.42-0.63) with specificity fixed at (SFA) 94%.[14-15] Cover test used for the detection of strabismus possessed sensitivity of 75% (95% CI: 57.7-89.9) and specificity of 100 % (16). With SFA 94%, the cover-uncover test produced a sensitivity of 27% (95% CI: 17-37)(15). Morale et al. used the Worths 4-dot test and has yielded sensitivity of 91.6% and specificity of 96.3% (17).

Considering the high sensitivity and specificity returned in our study, it is likely that the CDC method may as well be an equally effective tool for screening of ARF. Moreover, it is quick, simple and easy to perform over large groups. It may be effectively employed for screening purposes and help prevent childhood blindness. Further a major advantage over BT and MBT is that this can be easily documented, making it better for patients acceptability and understanding. Parent counselling for treating amblyopia becomes very easy with the photographs showing abnormal red reflex. It helps in better compliance related to management of amblyopia. The CDC generated bruckners test also eliminates inter and intra observer variations.

The shortcomings of this study include the small sample size. Hence the results require validation over large population and appropriate age groups. Despite this limitation, the outcomes of this study reveal that the use of CDC for eliciting bruckner reflex can as well be a potent screening tool for amblyogenic risk factors.

The present study revealed that the use of CDC in eliciting red reflex in pediatric population is as effective as Bruckners Test. It can diagnose strabismus and refractive errors with comparable specificity and sensitivity to other previously used tests.

**References:**
1. Gilbert C, Foster A. Childhood blindness in the context of VISION 2020--the right to sight. Bull World Health Organ. 2001;79(3):227-32.
2. Nirmalan PK, Sheeladevi S, Tamilselvi V, Victor AC, Vijayalakshmi P, Rahmathullah L. Perceptions of eye diseases and eye care needs of childrenamong parentsin rural south India : the Kariapatti Pediatric Eye Evaluation Project (KEEP ). Indian J Ophthalmol. 2004 Jun;52(2):163-7.
3. Robaei D, Rose KA, Ojaimi E, Kifley A, Martin FJ, Mitchell P. Causes and associations of amblyopia in a population-based sample of 6-year-old Australian children. Arch Ophthalmol. 2006 Jun;124(6):878-84.
4. Pediatric Eye Disease Investigator Group. A comparison of atropine and patching treatments for moderate amblyopia by patient age, cause of amblyopia, depth of amblyopia, and other factors. Ophthalmology. 2003 Aug;110(8):1632-7.
5. Kothari MT, Turakhia JK, Vijayalakshmi P, Karthika A, Nirmalan PK. Can the bruckner test be used as a rapid screening test to detectamblyogenic factors in developing countries? Am Orthopt J. 2003;53:121-6.
6. Sadat AO, Abadan KA, Sharma R, Danish A. Beyond photography: evaluation of the consumer digital camera to identify strabismus and anisometropia by analyzing the Bruckner's reflex. Indian J Ophthalmol. 2013 Oct;61(10):608-11.
7. Ottar WL, Scott WE, Holgado SI. Photoscreening for amblyogenic factors. J Pediatr Ophthalmol Strabismus 1995;32:289-95.
8. Barry JC, Konig HH. Non-cycloplegic screening of amblyopia via refractive findings with the Nikon Retinomax hand held autorefracter in 3 year old kindergarten child. Br J Ophthalmol 2001;85:1179-82.
9. Donahue SP, Johnson TP, Ottar W, Scott WE. Sensitivity of photoscreeners to detect high magnitude amblyogenic factors. J AAPOS 2002;6:86-91.
10. Kothari MT. Can the Bruckner test be used as a rapid screening test to detect significant refractive

errors in children? Indian J Ophthalmol. 2007 May-Jun;55(3):213-5.

11. Amitava AK, Kewlani D, Khan Z, Razzak A. Assessment of a modification of Brückner's test as a screening modality for anisometropia and strabismus. Oman J Ophthalmol 2010;3:131-5.

12. Magramm I. Amblyopia: etiology, detection, and treatment. Pediatr Rev. 1992 Jan;13(1):7-14.

13. Simmers AJ, Gray LS, Spowart K. Screening for amblyopia: A comparison of pediatric letter tests. Br J Ophthalmol 1997;81:465-9.

14. Schmidt P, Maguire P, Dobson V, Quinn G, Ciner E, Cyert L, *et al*. Comparison of preschool vision screening test as administered by licensed eye care professionals in Vision in preschoolers study. Ophthalmology 2004;111:637-50.

15. Ying GS, Kulp MT, Maguire M, Ciner F, Cyert L, Schimdt P, *et al*. Sensitivity of screening tests in detecting vision in preschoolers-targeted vision disorders when specificity is set at 94%. Optom Vis Sci 2005;82:432-8.

16. Williams C, Harrad RA, Harvey I, Sparrow JM. ALSPAC Study Team. Screening for amblyopia in preschool children: Results of a population-based, randomized controlled trial. Ophthalmic Epidemiol 2001;8:279-95.

17. Morale SE, Jeffery BG, Fawcett SL, Stager DR, Salomao SR, Berezovsky A, et al. Preschool worth 4 shape test: Testability, reliability, validity. J AAPOS 2002;6:247-5