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Comparison of Spot Vision Screener and Retinoscopy for Detecting Refractive Errors in Children and Adults in a Tertiary Care Eye Hospital

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ABSTRACT

Introduction

Hand held photoscreeners are found to be useful for detecting significant refractive error and amblyopic risk factors in very young, preverbal and children with disabilities. Our study aims to determine the accuracy of spot vision screener compared to retinoscopy in screening refractive errors in both children and adults.

Methods

A total 388 eyes of 194 patients, 113 adults and 81 children underwent refractive error measurement through retinoscopy and spot vision screeners. Comparison of the findings of dry retinoscopy and spot vision was done for both adults and children. Cycloplegic comparison was done for children. Bland-Altman analysis was done to determine the limit of agreement between the measurements of two methods.

Results

The mean difference in spherical equivalent between spot vision screener and dry retinoscopy among both eyes of 113 adults was 0.08±0.18D. Among both eyes of 81children administered non-cycloplegic refraction the mean difference was 0.19±0.28D.A total of 25 children had both dry and wet refraction; among these children the mean difference before cycloplegia was 0.25±0.21D and the mean difference after cycloplegia was 0.05±0.40D. Bland-Altman analysis showed a good agreement between both methods in adults and children.

Conclusions

The spot vision screener showed no significant difference both clinically and statistically in both adults and children, with more accurate in children after cycloplegia. Spot vision screener can be used as a tool for screening refractive errors, but still retinoscopy with subjective refinement should be considered as the gold standard for refractive error correction

Keywords: retinoscopy; spot vision screener; refractive error.

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INTRODUCTION

Uncorrected refractive errors are the main cause of visual impairment and second cause of blindness worldwide.[1] Visual impairment affects estimated 284 million people in the world among whom 43% have uncorrected refractive errors according to the World Health Organization 2011 report.[2] Refraction and ophthalmic dispensing services are very limited and people do not have access to a pair of glasses in many parts of the world, particularly in the developing countries. Early detection and correction of refractive errors in young children is very important. In pre-school and school- aged children, uncorrected refractive errors can cause serious limitations, which can compromise intellectual and psychological development as well as academic performance, resulting in potentially lifelong negative effects[3]. Significant uncorrected refractive in young children can lead to amblyopia.

Retinoscopy is the most widely used objective method of refraction and cycloplegic refraction is considered as the gold standard for assessment of refractive errors in both children and adults.[4-7] Retinoscopy requires more time, depends on the examiner and can only be performed by trained and skilled professionals.[8] So many other alternatives for detecting refractive errors like auto refractors are widely used in clinics. Recently portable devices like photo refractors are in use for screening significant refractive errors and other amblyopia risk factors in pre-school children. Photo refractors are very easy to use and can be performed even by non- technical person after brief orientation. Development of portable hand held devices is an important advancement because there is no problem related to positioning of forehead and chin rest, which is major problem for very small children and children with disabilities. Photo refraction technique was originally developed as a screening tool to rule out amylogenic ametropias in children.[9-11] Photoscreeners can also be used to screen refractive error in adults usually in the camps and to improve access to ocular health care services for socioeconomically disadvantaged population.

Effectiveness of photorefractive devices has been tested for detection of anisometropia, hyperopia, myopia, and astigmatism, but there are some devices that include further analysis of the eye misalignment, ptosis, or lens opacity.[12] There are a number of hand held photoscreener devices with the published reports of their utility in the clinical settings. These includes spot vision screener (Welch Allyn, Skaneateles Falls, NY),2WIN (Adaptica, Padova, Italy) S12C/R Mobile Vision Screener autorefractor(Plusoptix, Nuremberg, Gemany), the iScreen 3000 photoscreener(iScreen Vision Inc,Cordova,TN), the OPTEC 5500vision screener(Stereo Optical Co.IN,Chicago,IL), the GoCheck Kids Smartphone photo screening application(Goquity Mobile Health Scottsadle,AZ) and the Pediatric Vision Scanner or "blinq"(Rebion, Boston, A).[13]

The Spot (PediaVision, Lake Mary, FL, USA or Welch Allyn, Skaneateles Falls, NY, USA) vision screener was introduced in 2011 as a successor of the SureSight (handheld monocular photoscreener).[5] Most of the studies available to date regarding spot vision screener are done to find its accuracy in determining significant refractive errors and other amylogenic factors in children. Only few articles are available where they have used both adult and child population. This study aims to determine the accuracy of spot vision screener with retinoscopy as gold standard in detecting refractive errors in both adults and children and also to compare the cycloplegic and non-cycloplegic findings in children with both retinoscopy and spot vision screener.

METHODS

A prospective hospital based study was conducted at Bharatpur Eye Hospital after the approval from the hospital research committee and the ethical committee of Amity University. Consent was obtained from each participant before enrolling in the study. All the relevant particulars and demographic details were recorded. Comprehensive ocular examination was carried out for all participants. Presenting and best corrected visual acuity of each participant was recorded for each eye. After detail ocular examination and history taking, patient found eligible for the study first underwent refractive screening through spot vision screener. Spot vision screener was performed by an assistant who was an optical helper without prior knowledge of spot vision. The assistant was orientated about the instrument and was trained to perform the procedures and make recordings. Single optometrist performed retinoscopy with streak retinoscope who was masked for the spot vision finding. Non cycloplegic measurements were obtained from both spot and retinoscopy for all adults and children not indicated for cyclo. Cycloplegic refraction measurements through spot vision screener and retinoscopy were obtained both before and after cycloplegia for children indicated for cycloplegic refraction. For cycloplegia 1% cyclopentolate eye drop was instilled three times at 10 minutes interval and pupillary light reaction of the child was checked 45 minutes after the last administration. Measurements from spot vision screener and retinoscopy were taken only after full cycloplegia. Subjective refinement of the power was done for each participants and the final prescription was recorded for both eyes for all participants. The spherical and cylindrical power obtained from both retinoscopy and spot screener were converted and expressed as spherical equivalent. Bland Altman analysis/ plots were done to evaluate the agreement of the measurements from spot vision screener with streak retinoscopy as gold standard only taking the measurements of right eye. A paired t- test was used to test the difference between the results obtained from spot screener and retinoscopy.

RESULTS

A total 194 participants were enrolled in the study. There were 102(52.57%) males and 92(47.43%) females. The mean age of the participants was 27.72±17.60 years. There were 113(58.24%) adults and 81(41.76%) child participants. The mean age of adult participants was 39.60±13.40 years with age range of 19-66 years and the mean age of children was 11.14±4.29 years with age range of 2-18 years.

The mean spherical equivalent (SE) measured by retinoscopy was found to be 1.55±1.64D and that measured by spot vision screener was 1.47±1.46D in adults. Mean spherical value from retinoscopy and spot vision were 1.47±1.48D and 1.48±1.40D respectively. Spot vision underestimated myopia and overestimated hypermetropia.(Table-1). The mean cylindrical power determined by retinoscopy was 0.75±0.89D and that by spot vision screener was 0.81±0.72D.

Table 1. Noncycloplegic retinoscopy and spot vision screener findings in adults. (n=226 eyes)

Components	Retinoscopy	Spot vision screener	p-Value
Mean Spherical Equivalent	1.55±1.64D	1.47±1.46D	0.743
Mean spherical value	1.47±1.48D	1.48±1.40D	0.962
Mean SE(Myopia)	-1.85±1.88D	-1.63±1.74D	0.372
Mean SE(Hyperopia)	+1.11±0.89D	+1.32±1.12D	0.129
Mean cylinder	0.70±0.89D	0.81±0.72D	0.149

In retinoscopy findings the mean spherical equivalent for hyperopic error in children was found to be +2.17±2.41D and the mean spherical equivalent for myopic error was -2.76±2.34D. In the spot vision screener findings the mean spherical equivalent value for hyperopic error was found to be +2.10±2.44D and the mean value of spherical equivalent for myopic error was -2.40±1.99D.

Table 2. Non cycloplegic retinoscopy and spot vision findings in children.

Components	Retinoscopy	Spot vision screener	Difference (spot-ret)	P-value
Mean Spherical Equivalent	2.45±2.46D	2.26±2.18D	-0.19±0.28D	0.393
Mean spherical value	2.45±2.24D	2.26±2.15D	-0.19±0.09D	0.308
Mean SE(Myopia)	-2.76±2.34D	-2.40±1.99D	0.36±0.35D	0.272
Mean SE(Hyperopia)	+2.17±2.41D	+2.10±2.44D	-0.07±0.03D	0.875
Mean Cylinder	0.96±1.04D	1.22±0.10D	0.26±0.9 D	0.04

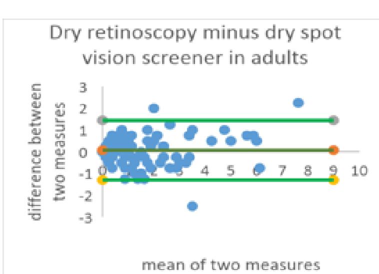
Out of 81 children 25 children were indicated for cycloplegic refraction. Mean spherical equivalent (SE) for refractive errors determined by spot vision screener was 3.25±2.75D compared to 3.50±2.96D determined by retinoscopy, indicating that spot vision screener slightly underestimated the errors. . The two techniques had almost similar findings for cylindrical power under cycloplegia but spot vision underestimated cylindrical power under noncycloplegic state.

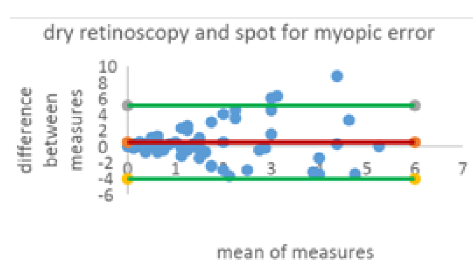
Table 3. Cycloplegic findings with retinoscopy versus spot vision screener.

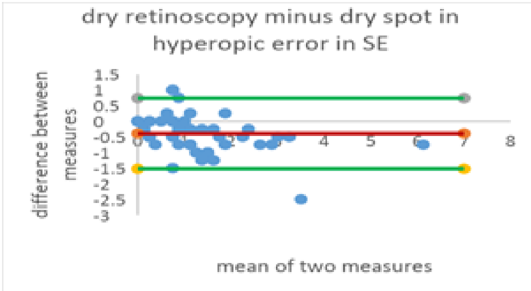
Components	Dry Ret	Dry Spot	Diff	P-value	Cyclo Ret	Cyclo Spot	Diff	P- Value
Mean SE(D)	3.50±2.96	3.25±2.75	0.25±0.21	0.32	4.05±2.99	4.00±2.59	0.05±0.40	0.96
Mean Sphere(D)	3.65±2.75	3.53±2.68	0.12±0.07	0.839	3.89±2.59	4.42±2.24	0.53±0.35	0.28
Mean Cyl	1.96±1.32	1.84±1.64	0.12±0.32	0.85	1.71±1.49	1.71±1.67	0.00±0.18	0.49

Table 4. Mean difference and 95% limits of agreement (LOA) between measurements of dry retinoscopy and dry spot screener in Adults.

Component	Dry retinoscopy Vs dry spot vision
Spherical Equivalent(SE)-all error	Mean difference, D= 0.075(-1.292-1.44)
SE- Myopic error	Mean difference, D= 0.488(-4.10-5.07)
SE-Hyperopic error	Mean difference, D= - 0.392(-1.52-0.73)
Cylindrical power	Mean difference, D= -0.10(1.575-1.792)
Cylindrical axis	Mean difference, Degree = -6.63(-159-146.60)







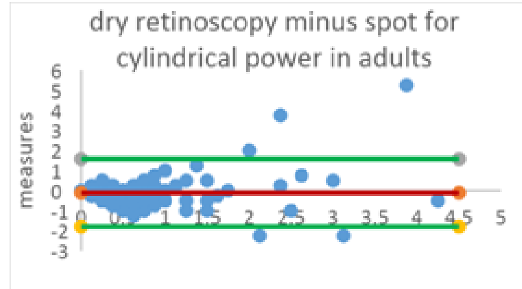
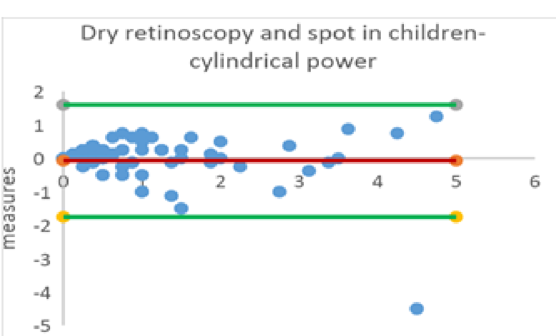
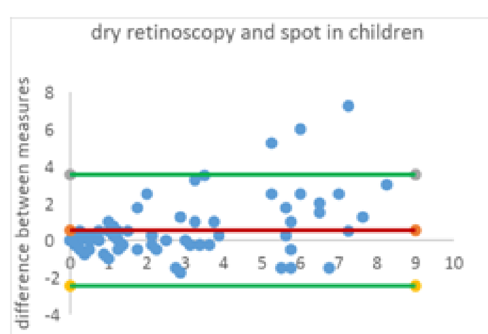
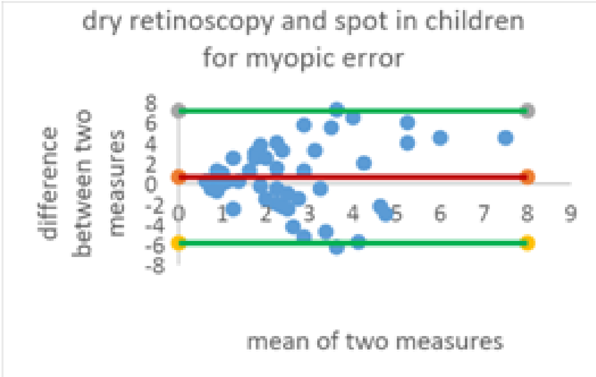
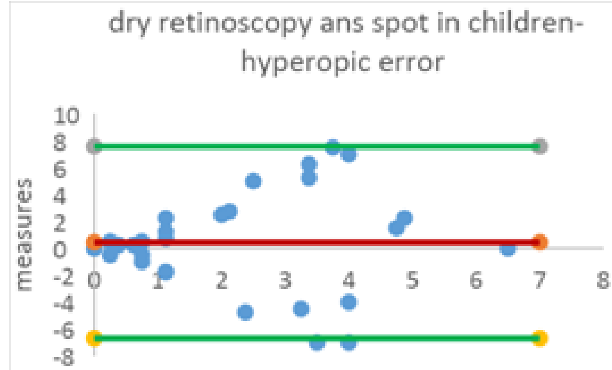


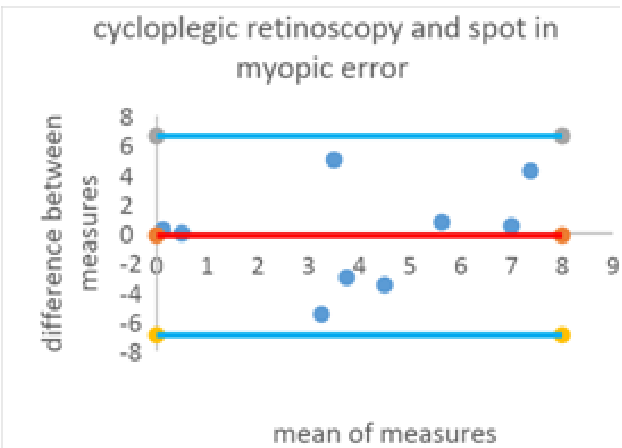
Table 5. Mean difference and 95% limits of agreement (LOA) between measurements of dry/cycloplegic retinoscopy and dry/cycloplegic spot screener measurements in Children.		
Components	**Dry retinoscopy and dry spot measurements n= 162 eyes**	**Cycloplegic retinoscopy and spot measurements n=50 eyes**
Spherical equivalent(SE)-all errors		
Mean difference, D	0.54	0.056
LOA-Upper	3.55	2.684
LOA-Lower	-2.46	-2.570
SE, Myopic error		
Mean difference, D	0.654	-0.138
LOA- Upper	7.149	6.624
LOA-Lower	-5.841	-6.902
SE, Hyperopic error		
Mean difference, D	0.450	0.269
LOA-Upper	7.584	6.092
LOA-lower	-6.684	-5.554
Cylindrical power		
Mean difference, D	0.076	1.805
LOA- upper	1.600	4.8044
LOA-lower	-1.751	-1.194
Cylindrical axis		
Mean difference, D	37.78	56.291
LOA-upper	256.29	232.699
LOA-lower	- 180.71	-120.116

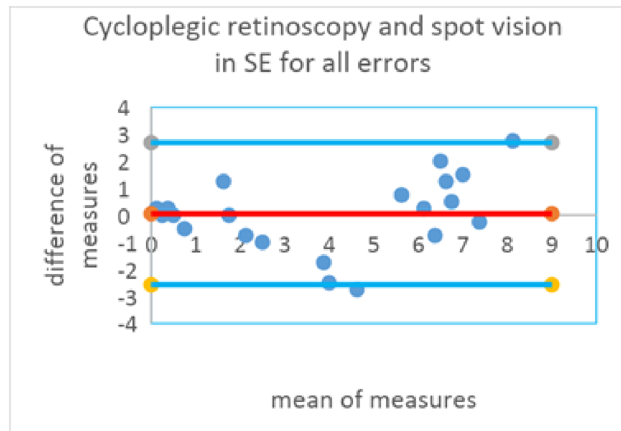


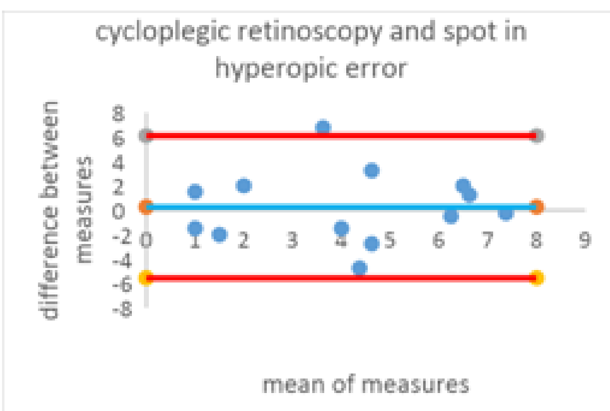












DISCUSSION

Refractive error is the most common ocular morbidity among patients of all age groups seeking eye care services. It can be easily detected and corrected by dispensing a pair of glasses. Although retinoscopy is the most widely used and gold standard method of determining refractive errors in both children and adults, there are other various methods like autorefractor and photorefractors. There are many studies done to determine the sensitivity and specificity of SVS in detecting amblyopic risk factors in children. In the study comparison of the measurements from the spot vision screener, an autorefractor based on principle of photorefraction was compared with the retinoscopy in both children and adults. We also compared the cycloplegic findings of both spot vision screener and the retinoscopy in children indicated for cycloplegic refraction. There was a very minimum difference (0.08D) between the mean values of spherical equivalent measurements of dry retinoscopy and dry spot vision screener in adults. The mean difference in SE measurements between the two instruments was not found to be statistically (P=0.743) significant or clinically meaningful. The mean difference between dry retinoscopy and SVS was 0.075D, with upper and lower LOA of 1.44 to -1.29D through Bland-Altman analysis.

This finding of our study is different from the study done by Panda et al in adult population where the difference between dry retinoscopy and spot vision was found to be 0.32D.[20] The mean cylindrical power measured by SVS was slightly greater than measured by retinoscopy, but the difference was not statistically significant(P=0.149). The difference in cylindrical power measured by SVS and retinoscopy without cycloplegia was found to be statistically significant (P= 0.04) with SVS overestimating the cylindrical power compared to retinoscopy, but the difference is not clinically relevant. Study conducted by Jesus DL et al found that SVS tended to overestimate both spherical and cylindrical power.[14] This study was done in both in adults and children with cycloplegia and the comparison was done with the subjective acceptance. SVS slightly underestimated myopic error (P=0.372), but slightly overestimated the hyperopic error (P=0.129) compared to dry retinoscopy, but the difference was not statistically and clinically significant for both errors. This may be because of the less role of accommodation in refractive error measurements for adults. Similar to our study findings, overestimation for hyperopia and underestimation for myopia by SVS was also found by study conducted by Panda et al in adults' populations.[20]

In children the mean difference of the measurements in spherical equivalent obtained from dry SVS was found to be slightly less than that of dry retinoscopy. The difference is not statistically and clinically significant (P=0.743). As in the adults SVS slightly underestimated myopia and overestimated hypermetropia, but the difference in findings for both the errors is not statistically and clinically significant. The mean cylindrical power measured by SVS was slightly greater than measured by retinoscopy. In contrast to our study, although there was no significant difference in mean spherical and cylindrical power measured by dry photorefraction, but significant difference was obtained for hypermetropic error (P=0.001) in a study conducted by ZhaleRajani to find if noncycloplegic photorefraction was applicable for screening amblyopia risk factors[21].This may be different because in the study the cycloplegic refraction was considered as gold standard and Plusoptix S04 photoscreener was used.

Our study also compared the cycloplegic measurements of SVS and retinoscopy in children. Under cycloplegic it was found that mean SE was slightly higher for SVS than retinoscopy. SVS slightly overestimated hypermetropia and underestimated myopia with no statistically and clinically significant difference. In contrast to noncycloplegic findings, the mean cylindrical power was almost similar for both SVS and retinoscopy under cycloplegia. Study done among Chinese pre-school and school aged children showed better performance of SVS in detection of cylinder.[25] Different to our study findings, a study done by Schimitzek T et al found that the accuracy of cylindrical power and axis decreased after cycloplegia, but accuracy improved for spherical equivalent.[26] Bland-Altman analysis showed the good agreement between measurements obtained from dry SVS and retinoscopy in adults and both dry and cycloplegic condition in children. But much greater agreement was obtained between the two measurements in cycloplegic condition than in noncycloplegic, indicating that measurement of SVS was more accurate under cycloplegic condition in children.

Although spot vision screener is widely used for screening significant refractive error and factors causing amblyopia, our study aimed to find if this hand held autorefractor is effective in screening refractive errors in older children and adults.

Inclusion of participants of all age groups and comparing the results in both children and adults was the strength of the study. Also comparison was made in children in dry and cycloplegic state. The limitation of the study lies in the fact that the overall sample size was less and it was even less for children indicated for cycloplegia to make a better conclusion on accuracy of SVS under cycloplegia. Further study is required with enough sample size for both adults and children to better establish the accuracy of SVS compared to retinoscopy.

CONCLUSIONS

The spot vision screener showed no statistically significant difference compared to retinoscopy in both adults and children, and was more accurate in children after cycloplegia. Spot vision screener can be used as a tool for screening refractive errors in children and adults, but still retinoscopy with subjective refinement should be considered the gold standard for refractive correction.

Conflict of interest: There is no conflict interest both financially or non-financially with any organization or product.

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