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Simple Retinoscopic Screening

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Summary
A simplified retinoscopic technique to screen for refractive errors in children is presented. The technique described was assessed in 98 children and the results correlated with full retinoscopic refractions. All tests were done with cycloplegia. Orthoptists' results using the simple retinoscopy compared well with the full retinoscopic findings of the ophthalmologists, with an overall sensitivity of 90% and specificity of 74%. These results compare favourably with more technical refractive screening methods.

This technique may be suitable as an adjunct to vision screening in pre-school children.

Why screen?
Ingram in 1977[1] reviewed cases of strabismus and amblyopia seen in one year and found that 75% of amblyopes identified after the age of 5 years had no detectable deviation clinically and suggested that a screening test was required to identify this group of 'straight eyed amblyopes' at an earlier age and thus prevent the amblyopia. He refracted a sample of children with esotropia and/or amblyopia[2] and found a significant association with hypermetropia of +2.0 DS or more and/or anisometropia of a similar amount. He therefore recommended considering refraction as a screening procedure. In 1979[3] he reported the effective use of full cycloplegic refraction in one year old children and a correlation of hypermetropia of +2.5 DS or more at this age with the development of later amblyopia and/or strabismus.

However, Ingram[4] found that spectacle correction of very high hypermetropia from the age of one year did not reduce the severity of amblyopia or incidence of strabismus, and suggested[5] that proposed screening at age three years for mild refractive errors has yet to be evaluated on a larger scale than his study population, perhaps by photorefraction. Ideally, if planning a refractive screening programme it should be demonstrable that the treatment offered is beneficial – *ie* that spectacle correction at an early age does reduce the prevalence of amblyopia and strabismus in the community. This would require a well planned prospective randomised trial. This is being done by Atkinson and preliminary reports (unpublished) suggest that spectacle corrected hyperopic infants do have a significantly lower incidence of strabismus and amblyopia than untreated hypermetropic infants.

Taylor[6] has argued that only bilateral visual handicap is socially significant and debilitating, whereas unilateral amblyopia is rarely debilitating unless there is injury to the other eye which is uncommon as shown by Tommila and Tarkkanen.[7] Taylor therefore recommends caution when considering a screening program lest it be cost ineffective and divert resources from important research in to the cause of amblyopia.

How to screen?
Having decided to screen for refractive errors

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Table I *Previously described methods of screenings for refractive errors*

			Use of Cycloplegia
RETINOSCOPIC			
FULL RETINOSCOPY	Ingram.	(3)	+
RAPID RETINOSCOPY	Friedman et al.	(8)	–
NEAR RETINOSCOPY	Mohindra.	(9)	–
PHOTOGRAPHIC			
Photographic screening.	Kaakinen	(10)	–/+
Otago photoscreener.	Molteno et al.	(11)	–
Photorefraction.	Atkinson et al.	(12)	–/+

the methods available include retinoscopic[3,8,9] and photorefractive.[10,11,12] (See Table I).

Ingram[3] used full cycloplegic retinoscopy as a screening technique and found it impractical as it was lengthy, and hence costly in terms of personnel.

Friedman *et al*[8] used rapid retinoscopy on 38,000 small children without cycloplegia and without trial lenses. This had a high false positive rate of almost 52%.

Mohindra[9] described a near retinoscopy technique without cycloplegia performed with monocular fixation at 50cms on the dim retinoscopy light and employing trial lenses. Mohindra's near refraction correlates well with full retinoscopy and is a possible alternative method for screening although it has not been used as such.

The photorefractive methods use relatively expensive equipment and correlate well with full retinoscopic refractions.

The photorefractive 'camera flash' technique used by Kaakinen[10] can screen for both strabismus and refractive errors by photography of corneal and fundus reflexes without cycloplegia. The accuracy is increased with cycloplegia.

The Otago photoscreener[11] also uses a camera to detect both strabismus and refractive errors without the use of cycloplegia.

Isotropic photorefraction by Atkinson *et al*[12] uses three photographs, one of the pupils and two with set values of defocus to produce 'blur circles', the size of which are used to calculate focusing and hence refractive status of the eye. Cycloplegia is not usually used.

Photorefraction has proved an invaluable research tool in vision research greatly contributing to our knowledge of the type and changes of refraction with age in children.[13,14] However, photorefraction has not found widespread application as a screening method in this country. The methods are technical, require interpretation and may be costly, e.g. video photorefraction.

Table II

Basic equipment
guttae cyclopentolate 1%
streak retinoscope
plus 3 ds lens

Who should do the screening?

Orthoptists are already involved in vision screening programmes for the detection of amblyopia and squint. This role might appropriately be extended to include screening for refractive errors which can be significant in the development of amblyopia and strabismus.

The aim of this study was to see if orthoptists could use a simple retinoscopic screening technique, to detect refractive errors in children; it does not question the rationale for screening, only offers a possible method.

Methods

Ninety-eight consecutive children, aged 6 months to 11 years, median 2 years, newly referred to the Orthoptic Department in Cardiff were screened for refractive errors by an orthoptist using simplified retinoscopy under cycloplegia. (See Table II for basic equipment used). Those children found to have refractive errors were placed into four categories according to defined criteria

Table III *Criteria used for diagnostic classification*

1 MYOPIA :	Light reflex AGAINST movement without any lens. THRESHOLD −1.5 DS
2 HYPERMETROPIA:	Light reflex WITH movement with +3.0DS lens. THRESHOLD +1.5 DS
3 ASTIGMATISM :	Light reflex DIFFERENT between vertical and horizontal axis. THRESHOLD +0.5 DS
4 ANISOMETROPIA:	Light reflex DIFFERENT between eyes. THRESHOLD +0.5 DS

(Table III). The simple retinoscopic test uses a streak retinoscope first without and then with a plus 3.0 DS lens both in the horizontal and vertical meridian of each eye. The orthoptist was asked simply to note the direction of movement of the retinoscopic shadow in each of the four test situations on each eye, thus detecting approximately myopia or hypermetropia exceeding 1.5 D and anything more than a small astigmatic error or anisometropia.

Each child was then refracted by an ophthalmologist. All tests were performed in a dim room at a working distance of 2/3 m under cyclopentolate 1% cycloplegia. Neither the orthoptist nor the ophthalmologist had prior information on the child or of each other's findings. The refractive classifications by the orthoptists using simple retinoscopy were compared with the full retinoscopic refractions by the opthalmologists and the sensitivity and specificity of the orthoptist's screening were computed. The McNemar test was used to assess the significance of differences.

Results

The results are presented in Tables IV and V.

The orthoptists were good at detecting children with significant refractive errors; they missed 4/93 (4.3%). The significant difference overall between the orthoptist and ophthalmologist was due to overdiagnosis 14/93 (15%) which was particularly true for hypermetropia and astigmatism.

The number of unco-operative children was 5/98 (5.1%) who were all infants. The results of repeat screening of these children are not included in the Tables.

Discussion

The results using simple retinoscopy compare favourably with other methods of screening described. It is not possible to compare all the methods directly because the data presented are not always in a similar form and the refractive thresholds selected differ slightly. (Table VI).

In this study using simple retinoscopy + 1.5D was allowed for working distance with no subtraction made for cycloplegia. Hence, when using either no lens in front of the child a threshold of −1.5DS is detected and with a +3.0 DS lens a refractive threshold of +1.5DS. The orthoptists detected low amounts of astigmatism and anisometropia easily.

Eleven orthoptists participated in the study after receiving a brief instruction period; their individual relative inexperience contributed initially to the number of false negatives which decreased with their increasing expertise as the study progressed. Inadequate cycloplegia probably contributed to a small number of false negatives. The over-referral rate of 15% (false positives) included children with off axis retinoscopy. These are practical points which once recognised can be avoided. The rate of overdiagnosis is acceptable for a screening method especially as it should reduce with practice.

Rapid retinoscopy by Friedmann[8] without cycloplegia has a false positive rate of almost 52%. Photorefraction using Kaakinen's method without cycloplegia[15] had a low false positive rate and the small number of false negatives were of low refractive errors. The test without cycloplegia gives approximate values, not absolutes, and has a blind refractive interval between −3.0 and +1.0 D.S. The Otago Photoscreener[11] had a false positive rate of approximately 5% (8 children) when unco-operative children were excluded and no false negatives. This photorefractive

Table IV *Simple retinoscopy results by orthoptists*

93 patients. (98 children in study, 5 unco-operative)				
	True +ve	False +ve	True −ve	False −ve
Overall	36	14	39	4
Myopia	2	3	88	0
Hypermetropia	33	10	46	4
Astigmatism	13	13	66	1
Anisometropia	10	4	75	4

Where: True +ve means refractive error present
False +ve means refractive error falsely diagnosed as present
True −ve means no refractive error present
False −ve means refractive error missed

Table V *Results of simple refractions by orthoptists compared to full refractions by ophthalmologists and significance of differences*

	SENSITIVITY	*SPECIFICITY*	*DIFFERENCES*
Overall	90%	74%	$p < 0.05$
Myopia	100%	97%	N.S.
Hypermetropia	89%	82%	N.S.
Astigmatic	93%	81%	$p < 0.01$
Anisometropia	71.5%	95%	N.S.

Where: Sensitivity = True positives/All positives
Specificity = True negatives/All positives
The McNemar test was used to estimate the significance of differences.

Table VI *Refractive thresholds for other screening methods*

	HYPERMETROPIA	*MYOPIA*	*ASTIGMATISM*	*ANISOMETROPIA*
Rapid retinoscopy (Friedman et al[8])	+2.5	−0.5	1.0	1.0
Photographic Screening (Kaakinen[10])	+4.0	−2.0	significant	significant
Otago Photoscreener (Molteno et al[11])	+5.0	−2.0	1.0	1.0
Photorefraction (Atkinson et al[12])	+3.5	−0.5	0.5	0.5

method had an overall sensitivity of 93% and specificity of 82% evaluated in 161 children. Photorefraction by Atkinson *et al*[14] in 1096 children aged 6 to 9 months included less than 1% false positives (anisometropia) and from a control sample of 52 of 975 'normal' only one false negative, an equivalent rate of 1.9% false negatives. Unlike Kaakinen's method there was no blind refractive interval.

Screening with simple retinoscopy is a quick method of screening refractive errors and anisometropia indicating those children who require full evaluation by an experienced retinoscopist.

Conclusions

These results compare favourably with other more complex methods of screening and suggest that this test could be used by an orthoptist as an adjunct to vision screening in children under the direction of an ophthalmologist or community physician.

Full retinoscopy requires a skilled retinoscopist but this simple retinoscopy requires only very simple equipment, can easily be learnt and reliably used by an orthoptist who can handle children.

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