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Comparison of the Plusoptix S04 binocular autorefractor with cycloplegic refraction performed by an ophthalmologist

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Abstract

Aim: **To determine the accuracy of undilated binocular autorefraction using the PlusOptix S04 autorefractor, as compared with cycloplegic refraction performed by an ophthalmologist.**
Methods: **A retrospective search of orthoptic notes in Sligo General Hospital revealed 42 children (22 male, 20 female) who had a cycloplegic refraction performed by an ophthalmologist within 8 weeks of a PlusOptix S04 binocular autorefraction between March 2006 and July 2008. All children were under 8 years of age and had a deviation measurement of $<10^{\Delta}$. A local standard for an acceptable difference was set in conjunction with the consultant paediatric ophthalmologist. The completed data were sent to the clinical audit support team for collation and analysis.**
Results: **The standard for an acceptable spherical difference was only achieved in 67% of cases. The standard for an acceptable difference in anisometropia and astigmatism was achieved in 88% of cases.**
Conclusion: **The PlusOptix S04 binocular autorefractor was found to agree with a cycloplegic refraction performed by an ophthalmologist in 88% of anisometropic and astigmatic refractions. However, the spherical results were less reliable at only 67%. An underestimation of hypermetropia was shown. Therefore cycloplegic refraction performed by an ophthalmologist is still necessary and not replaceable by an autorefractor.**

Key words: Cycloplegic refraction, PlusOptix S04 autorefractor, Undilated binocular autorefraction

Introduction

Amblyopia is the most common cause of visual impairment in children.[1] It is a frequent cause of monocular vision loss in children.[2] For this reason, ascertaining a child's underlying need for glasses is very important as refractive correction is a powerful amblyopia treatment modality.[2]

The Plusoptix S04 autorefractor is a hand-held infrared photorefraction system with accompanying Windows database and interpretation capacity. It is easy to use and even young children show good compliance.[3] In fact a high testability rate of 99% (268/271) was found for this autorefractor.[4] The camera hand-piece is activated with a single trigger and focused while viewing the camera image on the computer screen. A threshold criterion for refractive error is entered into the database. Any result outside of this range will indicate the need for further investigation by results flagged up in red. The specifications in the instruction manual give a spherical and cylindrical range of +5DS/DC to −7DS/DC in 0.25DS/DC steps.

The Plusoptix S04 autorefractor has been in use in the orthoptic clinic at Sligo General Hospital for the last 3 years. Approximately 1200 children under the age of 8 years have been tested to date. It is used on a regular basis as an adjunct to full orthoptic investigation. At the outset of this audit, there were no data other than those supplied by the manufacturer pre-publication.[3] Since then new studies have been published,[5–8] detailing the accuracy of the autorefractor, mainly for vision screening. However, for certain reasons, such as study design, they are not directly comparable to this audit as it was not intended as a screening tool.

Aim

The aim of this audit was to determine the accuracy of the autorefractor as compared with cycloplegic refraction performed by an ophthalmologist. The results were then compared with a locally set standard for spheres, cylinders and intraocular differences.

Standards

The acceptable difference in all patients between the undilated Plusoptix autorefraction and the cycloplegic refraction (performed by an ophthalmologist) should be within:

±1.00 DS spherical
±0.75 DC astigmatism
±0.75 DS/DC anisometropia.

This standard was decided upon in conjunction with the paediatric consultant.

Methods

A retrospective audit was carried out within the Orthoptic Department in July 2008. Data were collected from orthoptic notes for children under the age of 8 years

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who attended the orthoptic clinic between March 2006 and July 2008. Forty-two children were included: 22 male and 20 female.

Inclusion criteria

The inclusion criteria for the audit were:

1. Cycloplegic refraction within 8 weeks of autorefraction.
2. Patient orthophoric or deviation $<10^{\Delta}$.

The completed data were sent to the clinical audit support team for collation and analysis.

Results

Spherical

The acceptable difference of $\pm$1.00DS was achieved in 67% (28/42) of cases. The remaining 33% (14/42) of cases differed by $>$1.00DS in one or both eyes. Of the 14 cases that failed to meet the standard, 7 had one eye which met the criteria and the difference of the second eye was either +1.25DS or +1.50DS. The other 7 cases were much further out of range, between 4DS and 6DS.

Astigmatism

The acceptable difference of $\pm$0.75DC was achieved in 88% (37/42) of cases. A further 2% (1/42) had no astigmatism present. The remaining 10% (4/42) had a difference which ranged from 1DC to 3.5DC.

Anisometropia

The acceptable difference of $\pm$0.75DS/DC was achieved in 88% (37/42) of cases. The other 12% (5/42) did not meet the standard. In 3 cases the spherical anisometropia ranged from 1DS to 2DS. In 2 cases the astigmatic anisometropia was 1DC and 1.25DC.

Discussion

Limits of our study

There were three main limitations to our study:

A small cohort

For comparison, 126 were in the study by Dahlmann-Noor *et al.*[5] A recent study by them found that the Plusoptix as a single screening test would miss a significant number of children with amblyopia or amblyogenic risk factors. This was based on comparison with orthoptic assessment. Therefore autorefraction can be used in conjunction with orthoptic assessment but not as a replacement. As previously mentioned, the autorefractor is not used as a screening tool in our department but as an adjunct to full orthoptic investigation.

Population base

Other studies which evaluated the autorefractor purely as a screening tool had a random population. This differs from our study which was hospital based. The patients who are being assessed have already been referred to the Orthoptic Department. They are not referred solely for autorefraction. This was also the case with the study by Ehrt *et al.*,[3] which, as hypothesised by Dahlmann-Noor *et al.*,[6] may have affected calculations due to the higher prevalence of eye disease in a hospital-based study population.

Deviation size/orthophoria

Not included in our audit were patients with deviations $>10^{\Delta}$. This was recently addressed by another study which found that in the presence of strabismus the autorefractor often fails to obtain a measurement.[5]

Dahlmann-Noor *et al.*[6] discussed the intra- and inter-observer repeatability. This was found to be not as insignificant as hoped: it was not expected that there would be significant variability between readings ($\pm$0.63–0.64DS). Taking this into consideration, the inter-observer variability was less surprising as it was within the same range as subsequent measurements acquired by the same observer.

Two orthoptists tested patients in this audit. Eight ophthalmologists carried out the refractions. The intra-examiner reliability and inter-examiner reliability of subjective refraction in most studies were close to 80% agreement within $\pm$0.25D and 95% agreement within $\pm$0.50D for spherical equivalent, sphere power and cylinder power as found by Goss and Grosvenor.[9] However, objective refractions with cycloplegia were carried out in our audit.

The underestimation of children's refractive error was illustrated by this audit, as was found by Dahlmann-Noor *et al.*[5] That study found a much lower rate of 20% (21/126) correlation, but the value of within $\pm$0.50DS is lower and therefore could perceivably bring our acceptance rate down to a similar level if the standard were reduced. However, when Dahlmann-Noor *et al.* increased their value to $\pm$1.00DS, only 35% (38/126) were within this value. Conversely Arthur *et al.*[4] found 94% (255/271) of their results agreed; however, they had wider parameters, for example anisometropia of $>$1DS and astigmatism of $>$1.25DS. Matta *et al.*[10] also found a referral rate of 67% (73/109) using the Plusoptix S04 autorefractor as a screening tool. This shows the difference between studies, as no two studies have exactly the same acceptable difference: those with a tighter standard gave a lower success rate[5] whereas the wider parameters for error yielded a much higher success rate.[4]

Also of note regarding underestimation of refractive error is the fact that the range of the autorefractor is only +5DS. The manufacturer's reason for this was that at this level cycloplegic refraction would already be indicated. In one of our cases the difference was 6DS, which given the autorefractor's range would not have been measurable.

Conclusion

The Plusoptix S04 binocular autorefractor was found to agree with a cycloplegic refraction performed by an ophthalmologist in 88% of anisometropic and astigmatic refractions. However, the spherical results were less

reliable at only 67%. An underestimation of hypermetropia was shown and in 17% of cases the underestimation was 4DS or above.

Therefore cycloplegic refraction as performed by an ophthalmologist is still necessary and not replaceable by an autorefractor.

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