Original Article

A Comparison of Automated and Manifest Refraction: The Effect of Age

Khayyam Durrani, Amanullah Khan, Sohail Ahmed, Jehangir Durrani

Pak J Ophthalmol 2006, Vol. 22 No. 3

See end of article for authors affiliations

Corrrespondence to:
Khayyam Durrani
Department of Ophthalmology and Community Health Sciences
Aga Khan University
Karachi, Pakistan

Received for publication
May' 2005

Purpose: Autorefraction without subjective refinement is being increasingly employed by opticians in Pakistan for prescribing glasses. The purpose of this study is to compare the refractive correction obtained by autorefraction alone and manifest refraction at a tertiary care hospital in Pakistan and to determine the relationship of this difference with age.

Material and Methods: Two hundred and sixty nine patients visiting the ophthalmology clinic of a large tertiary-care hospital in Karachi, Pakistan were studied. Autorefraction alone using a Canon R-10 Autorefractor and manifest refraction were performed at the same visit. A clinically significant difference between autorefraction and manifest refraction was defined as a difference of $\geq$0.50 D in sphere, cylinder, spherical equivalent or weighted axis, or $\geq$10° in axis.

Results: In 266 right eyes, the median difference between autorefraction and manifest refraction in spherical corrections was +0.01 D (p=0.85), -0.33 D in cylindrical corrections (p<0.01), 10° in axes (p<0.01), and –0.16 D in spherical equivalent (p=0.02). Children 10 years of age or younger were 2.23 times more likely to have a clinically significant difference in spherical corrections (OR: 2.23, 95% CI: 1.12-4.47).Comparable results were observed for the left eye.

Conclusions: There is a significant difference between the corrections obtained by autorefraction alone and manifest refraction, particularly in children. Autorefraction alone without subjective refinement cannot be substituted for manifest refraction, especially in children 10 years of age or younger.

It is widely accepted that autorefraction is not sufficiently accurate to substitute for subjective refraction for the purposes of prescribing spectacles[1,2]. Autorefraction without subjective refinement is being used by opticians in Pakistan as the sole method of prescribing glasses. We attempted to highlight this problem by comparing the corrective refractive error obtained by autorefraction with manifest refraction and to determine the relationship of this difference with age.

MATERIAL AND METHODS

A cross-sectional study based on hospital records at the Aga Khan University Hospital was performed. Patients having both autorefraction and manifest refraction performed on the same visit were included, while individuals with an ocular pathology causing opacity in the media were excluded from analysis. A convenience sample of 269 persons was performed and age, sex, sphere, cylinder and axis corrections obtained by automated and manifest refraction recorded. Spherical equivalents were calculated and

two tailed paired t-tests applied to compare corrections obtained by both methods in each individual. A clinically significant difference between autorefraction and manifest refraction was defined as a difference of ≥0.50 D in sphere, cylinder, or spherical equivalent or ≥10° in axis. Chi-square tests were performed after establishing cut-offs for age and clinically significant difference in refractive error.

RESULTS

In the 266 right eyes for which complete data were available, the median difference between auto-refraction and manifest refraction in spherical corrections was +0.01 D (p=0.85), -0.33 D in cylindrical corrections (p<0.01), 10° in axes (p<0.01), and -0.16 D in spherical equivalent (p=0.02) (Table 1a). For cylinder corrections, the median difference between the two methods varied from -0.20 D to -0.53 D, a finding that was statistically different across all age groups (Table 2a). Children 10 years of age or younger were 2.23 times more likely to have a clinically significant difference in spherical corrections [Odds Ratio (OR): 2.23, 95% Confidence interval (CI): 1.12-4.47] (Table 3a). Comparable results were observed for the 269 left eyes analyzed (Tables 1b-3b).

DISCUSSION

Automated infrared refractors, or autorefractors, are microcomputers that employ the optometer principle and infrared waves to objectively determine the refractive error of subjects in a clinical setting. The first modern autorefractors were developed in 1937. However, it was not until the early 1970s that necessary advances in electronics were made to allow for routine use of the instrument in clinical practice. During the 1980s, Coherent Medical's instrument, Dioptron (1974) was largely replaced by the more compact and reliable Canon Autoref F-1 and Nidek AR-2000. So much so, in fact, that at the present moment, their genre is almost invariably used from solo office practices to the outpatient departments of large tertiary care hospitals in Pakistan and throughout the world. The main reason behind this trend is thought to be the speed and relative consistency with which these devices detect and quantify refractive errors, and their ability to provide a reliable starting point from which to measure subjective refraction[1,2].

Table 1a: Mean Difference between auto refraction and subjective. Refraction, Right eye

	Mean difference	**Standard deviation**	**P-value**
Sphere	0.01	1.06	0.85
Cylinder	-0.33	0.89	<0.01
Axis	9	34	<0.01
Spherical Equivalent	-0.16	1.04	0.02

Table 1b: Mean Difference between auto refraction and subjective. Refraction, Left eye

	Mean difference	**Standard deviation**	**P-value**
Sphere	0.10	0.81	0.04
Cylinder	-0.37	0.99	<0.01
Axis	7	38	<0.01
Spherical Equivalent	-0.09	0.74	0.06

Table 2a: Mean Difference between auto refraction and subjective. Refraction by age, Right eye

Age (Y)	**No**	**Sph**	**Cye**	**Axis**	**S E**
1-10	48	0.32	-0.53	5	0.06
11-20	47	-0.18	-0.38	9	-0.37
21-30	55	-0.12	-0.30	10	-.27
31-40	53	0.11	-0.29	15	-0.04
>40	59	-0.03	-0.20	7	-0.13

P=0.05, p=0.01 -0.049, p<0.01; n=262

Table 2b: Mean Difference between auto refraction and subjective. Refraction by age, Left eye

Age (Y)	**No**	**Sph**	**Cye**	**Axis**	**S E**
1-10	51	0.52	-0.53	13	0.26
11-20	48	-0.11	-0.28	3	-0.25
21-30	56	-0.01	-0.44	5	-0.23
31-40	52	0.01	-0.28	14	-0.13
>40	58	-0.09	-0.34	2	-0.07

P=0.05, p=0.01 -0.049, p<0.01; n=265

Numerous independent studies have evaluated the performance of automated refractors in clinical settings[3-7]. This research has generally highlighted the fact that there is a significant difference between the refractive errors determined by the objective autorefractors and the manifest refraction assessed by conventional subjective means. This difference is such that the autorefractor alone without subjective testing refinements cannot be substituted for conventional complete refraction with subjective refinement[8-12]. The discrepancy has also been shown to vary significantly with age[13,14]. All the evidence notwithstanding, the practice observed in Pakistan is quite different. Although no studies have been conducted to date, it is generally believed that the use of autorefractors has mushroomed to such an extent that many opticians use these devices as the sole means of prescribing lenses to patients with decreased visual acuity. This could lead to inappropriate and inaccurate prescriptions, leading in turn to suboptimal visual acuity, asthenopia, and even loss of vision if a more sinister reason lies behind the blurred vision and remains undetected. This is especially important in children as inadequately corrected refractive errors may result in irreversible long-term sequelae in later life[15,16].

We found that significant differences occurred in the refractions obtained by automated and manifest refraction in cylinders, axes, and spherical equivalent. A statistically significant difference in the cylindrical corrections attained by both methods was present in all age groups analyzed, but differences in sphere were significant only in children and adolescents. This additional discrepancy in younger individuals is consistent with previously published data, and may be secondary to the difficulties in fixation and repeated blinking during autorefraction that are more frequent in this age group[10,14]

Of particular concern is the finding that children ten years of age or younger were at a higher risk of having a clinically significant difference in the spheres obtained by both methods, being 2.23 to 3.47 times more likely to have such a difference when compared with patients above the age of 10. A substantial number of these patients had a difference greater that the minimum cutoffs of 0.5 D or 10° in axes used for the purposes of this study. Inadequately corrected refractive error is a major risk factor for the development of amblyopia[15]. The deleterious effects of amblyopia can be serious and wide ranging, including strabismus, loss of binocularity, restricted future employment opportunities, and increased risk for psychosocial problems[16,17]. It is also a widely held clinical belief that the risk of developing amblyopia and strabismus can be effectively reduced if abnormal refractive errors can be identified and adequately corrected at a young age[18,19].

Table 3a: Odd Ratios of a clinically significant difference between auto refraction and subjective refraction[a] in patients <10 years of age[b], Right eye

	Age	Patients n (%)	OR	95%CI
Sphere	<10 >10	29 (60) 87 (41)	2.23	1.12-4.47
Cylinder	<10 >10	29 (60) 106 (50)	1.56	0.78-3.11
Axis	<10 >10	18 (38) 100 (47)	0.68	0.43-1.37
Spherical	<10	23 (48)	1.22	0.62-2.41
Equivalent	>10	92 (43)		

[a]Clinical significance for diopteric powers: -.5< x <.5 and 10° x <170° for axes
[b]Total no of patients <10 years: 48 (18.3%); >10 years: 214 (81.7%); n=262
OR: Odds ratio, 95% CI: 95% Confidence Interval

Table 3b: Odd Ratios of a clinically significant difference between auto refraction and subjective refraction[a] in patients <10 years of age[b], Left eye

	Age	Patients n (%)	OR	95%CI
Sphere	<10 >10	33 (65) 74 (35)	3.47	1.74-6.96
Cylinder	<10 >10	36 (71) 111 (52)	2.23	1.09-4.58
Axis	<10 >10	29 (57) 93 (44)	1.72	1.27-4.90

Spherical	<10	29 (57)	2.49	0.88-3.35
Equivalent	>10	74 (35)		

[a]Clinical significance for diopteric powers: -.5< x <.5 and 10[o] x <170[o] for axes
[b]Total no of patients <10 years: 51 (19.2%); >10 years: 214 (80.8%); n=265
OR: Odds ratio, 95% CI: 95% Confidence Interval

CONCLUSION

In conclusion, there is both a statistically and clinically significant difference between autorefraction and manifest refraction when used in the Pakistani population. The magnitude of this difference is greater in children 10 years of age or younger. Autorefraction alone cannot be used to determine an individual's refractive error, especially in children.

Author's affiliation

Khayyam Durrani
Departments of Ophthalmology and Community Health Sciences, The Aga Khan University, Karachi, Pakistan

Amanullah Khan
Departments of Ophthalmology and Community Health Sciences, The Aga Khan University, Karachi, Pakistan

Sohail Ahmed
Departments of Ophthalmology and Community Health Sciences, The Aga Khan University, Karachi, Pakistan

Jehangir Durrani
Department of Ophthalmology, Shaikh Zayed Federal Postgraduate Medical Institute, Lahore, Pakistan

REFERENCES

1. **Goss DA, Grosvenor T:** Reliability of refraction- A literature review. J Am Optom Assoc 1996; 67: 619-30.
2. **Bullimore MA, Fusaro RE, Adams CW:** The repeatability of automated and clinician refraction. Optom Vis Sci. 1998; 75: 617-22.
3. **Dyson C:** A clinical study of the autorefractor, an automatic refracting device. Can J Ophthalmol 1997; 12: 29-33.
4. **Yeiw PT, Taylor SP:** Clinical evaluation of the Humphrey autorefractor. Ophthalmic Physiol Opt. 1989; 9: 171-5.
5. **Wood IC, Papas E, Burghardt D, Hardwick G:** A clinical evaluation of the Nidek autorefractor. Ophthalmic Physiol Opt. 1984; 4: 169-78.
6. **Salvesen S, Kohler M:** Automated refraction: A comparative study of automated refraction with the Nidek AR-1000 autorefractor and retinoscopy. Acta Ophthalmol Copenh. 1991; 69: 342-6.
7. **Pappas CJ, Anderson DR, Briese FW:** Is the autorefractor reading closest to manifest refraction? A comparison of the patient's previous spectacles and the 6600 autorefractor reading. Arch Ophthalmol. 1978; 96: 997-8.
8. **Pappas CJ, Anderson DR, Briese FW:** Clinical evaluation of the 6600 autorefractor. Arch Ophthalmol. 1978; 96: 993-6.
9. **Kinge B, Midelfart A, Jacobsen G:** Clinical evaluation of the Allergan Humphrey 500 autorefractor and the Nidek AR-1000 autorefractor. Br J Ophthalmol. 1996; 80: 35-9.
10. **Pesudovs K, Weisinger HS:** A comparison of autorefractor performance. Optom Vis Sci. 2004; 81: 554-8.
11. **Mallen EAH, Wolffsohn JS, Gilmartin B, et al:** Clinical evaluation of the Shin-Nippon SRW-5000 autorefractor in adults. Ophthal Physiol Opt. 2001; 21: 101-7.
12. **Jorge J, Queiros A, Almeida JB, et al:** Retinoscopy/ autorefraction: Which is the best starting point for a noncycloplegic refraction? Optom Vis Sci. 2005; 82: 64-8.
13. **Joubert L, Harris WF:** Excess of autorefraction over subjective refraction: Dependence on age. Optom Vis Sci. 1997; 74: 439-44.
14. **Chat SWS, Edwards MH:** Clinical evaluation of the Shin-Nippon SRW-5000 autorefractor in children. Ophthal Physiol Opt. 2001; 21: 87-100.
15. **Atkinson J, Braddick O, Robier B, et al:** Two infant vision screening programmes: Prediction and prevention of strabismus and amblyopia from photo- and videorefractive screening. 1996; 10: 189-98.
16. **Satterfield D, Keltner JL, Morrison TL:** Psychosocial aspects of strabismus study. Arch Ophthalmol. 1993; 111: 1100-5.
17. **Simon JW, Kaw P:** Commonly missed diagnoses in childhood eye examination. Am Fam Physician. 2001; 64: 623-8.
18. **Olitsky SE, Nelson LB:** Common ophthalmologic concerns in infants and children. Pediatr Clin North Am. 1998; 45: 993-1012.
19. **Kvarnstrom G, Jakobsson P, Lennerstrand G:** Visual screening of Swedish children: An ophthalmological evaluation. Acta Ophthalmol Scand. 2001, 79: 240-4.