■ *Original article*

Physiological disproportions between un-corrected vision and degree of myopia

Gupta Y[1], Rizvi SAR[2], Gupta M[3],
[1]Professor, [2]Assistant Professor, [3]Associate Professor
[1,2]Institute of Ophthalmology, [3] Department of Physiology
Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh-202002 (U.P.), India

Abstract

Introduction: Anomalies of the refractive state of the eye are the commonest cause of defective vision.

Purpose: To study the relationship between uncorrected visual acuity and refractive error in myopia in children, the prevalence of disparity between them and to find out the possible explanation for it.

Materials and methods: 100 eyes of 50 myopic children were studied and analyzed to study relationship between the uncorrected visual acuity (UCVA) and its refractive status. 42 cases were chosen to study disparity, either in the form of uncorrected visual acuity or refractive error. To study these disparities, Keratometery for anterior corneal curvature and A-scan for axial length and anterior chamber depth were also done.

Statistics: The results were analyzed statistically using student t-test while the relationship between uncorrected visual acuity (UCVA) and refractive error in myopia was obtained with Spearman's correlation coefficient (R).

Results: The strength of association of uncorrected visual acuity and myopia as indicated by the correlation coefficient (0.897, $p < 0.001$) is a significant one. Out of 42 cases taken to study disparity, 24 (57 %) cases showed discrepancy either in the form of uncorrected visual acuity or refractive error. The reason for this disparity as proven statistically in our study is increased axial length (p value< 0.001).

Conclusions: There exists a linear relationship between UCVA and myopia, yet an accurate prediction of uncorrected visual acuity cannot be made on the basis of the refractive error or vice-versa for any single individual, as there exists a disparity either in form of UCVA or refractive error in myopia.

Keywords: refractive error, myopia, uncorrected visual acuity, disparity, axial length

Introduction

Anomalies of the refractive state of the eye are the commonest cause of defective vision. Since vision is the major sensory modality in humans, normal vision is important for the general development of a child (Day S, 1997; Cass HD et al 1994). As a child with normal vision only achieves adult levels of visual function at about 5 years, it is difficult to predict the final visual outcome in children with visual defects (Rahi & Dezaleuv, 1998).

Myopia is a major cause of correctable visual loss worldwide (Dandone & Dandone, 2001). Since the degree of myopia is a sum of three factors of the

Received on: 03.01.2010 Accepted on: 04.06.2010
Correspondence and reprint request to: Prof Dr Yogesh Gupta, Institute of Ophthalmology, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh-202002 (U.P.), India

eye i.e. axial, curvatural and index, the visual acuity of an uncorrected eye would be expected to have a mathematical relationship to the degree of myopia. In other words, one would expect near about the same uncorrected vision in various eyes having a similar refractive error in terms of diopters or vice versa. Though it is impossible to predict accurately in any individual case what the uncorrected vision would be, it has been found that the visual acuity and refractive error in myopia are closely correlated (Crawford et al 1945; Hirsch MJ, 1945; Smith G, 1991). Generally, as the vision becomes poorer, the refractive error is expected to be greater. However, the association between these two variable is not a perfect one (Crawford et al 1945).

Many studies have been done in the past to study relationship between visual acuity and myopia in adults (Crawford et al 1945; Hirsch MJ, 1945; Smith G, 1991). Research was also done to study prevalence of myopia in children (Ferris F L et al 1982, Ojaimi E et al 2005, Morgan A et al 2006) and adults (Lo PI et al 1996; Onal S, 2007) but assessment of disparity between uncorrected visual acuity (UCVA) and refractive error in myopia has not been studied yet. We have observed that quite a few eyes do not follow the expected rule of having the same uncorrected vision in eyes of similar refractive error or vice-versa. Thus the present study is primarily designed to study the relationship between uncorrected visual acuity and refractive error in myopia in children, to find out the prevalence of disparity between them and find a possible explanation for this disparity.

Materials and methods

This prospective study was conducted between April 2008 to March 2009, in 50 cases of myopia. Inclusion criteria were myopic spherical equivalent $\geq$ -0.5D, age between 5 to 15 years and Best Corrected Visual Acuity (BCVA) of 6/6. Exclusion criteria for subjects were any ocular pathology or fundus abnormality that led to decreased vision.

This research was conducted in accordance with the Declaration of Helsinki and national and international standards.

With informed consent of the subject, Uncorrected Visual Acuity (UCVA) for distance was determined with an internally-illuminated rotating drum having Snellen's test type. Objective refraction was performed with a streak retinoscope under cycloplegia followed by subjective assessment after the effect of mydriatic had worn off. A Bausch and Lomb keratometer was used to measure anterior corneal curvature in all cases. Anterior chamber depth and axial length of eyes were measured using the Optikon 2000 A-scan model.

For statistical purposes, the Snellen visual acuity fraction was converted into the logarithm of the minimal angle of resolution (log MAR). First decimal visual acuity is obtained by dividing the numerator of the Snellen fraction by the denominator. The logarithm of the reciprocal of this decimal visual acuity approximates the Log MAR acuity.

For studying disparities between UCVA and myopia, we have preferred two eyes of the same subject to rule out the factor of variation in resolution among individual eyes. The total number of cases was divided into four groups. Group-A (36 eyes of 18 subjects) showed no discrepancies either in form of UCVA or refractive error. This group was taken as the control in our study. Group B (28 eyes of 14 subjects) showed discrepancy of UCVA of one line or more of Snellen test type in two eyes of the same subject, while refractive error remained same. Group-C (20 eyes of 10 subjects) showed discrepancy of 0.5D or more of refractive error in two eyes of the same subject, while UCVA remained same. Group-B and C constitute our test group as they showed a discrepancy in one form or another. Group-D (16 eyes of 8 subjects) showed discrepancy both in UCVA and refractive error and was not included in the study due to the erratic relationship between UCVA and refractive error in myopia. The parameters taken into consideration other than uncorrected visual acuity and refractive status to analyze these discrepancies were anterior corneal curvature, axial length and anterior chamber depth. The results were compared and analyzed statistically using student t-test. Spearman correlation coefficient (R) was used to study the relationship between visual acuity and myopia. Statistical significance was defined as $P< 0.05$. All statistical analysis was done using SPSS version 11.5.

Results

The strong strength of association between visual acuity and refractive error in myopia was observed with a Spearman correlation coefficient of 0.897 (p value< 0.001) which is significant at 0.01 level. The range of UCVA in our study was 6/9 to 1/60 while that of refractive errors was –0.5D to –11.0D (Table 1).

Table No. 1
Relationship between Visual Acuity and Refractive Error (Spherical Equivalent)

Uncorrected Visual Acuity and Log MAR Acuity

Refractive Error (D)	6/9 + 0.2	6/12 + 0.3	6/18 + 0.5	6/24 + 0.6	6/36 + 0.8	6/60 + 1.0	5/60 + 1.1	4/60 + 1.2	3/60 + 1.3	2/60 +1.5	1/60 + 1.8	Total	Mean Log MAR Acuity
– 0.5	3	-	-	-	-	-			-	-		3	0.2
–1.0	2	4	1	1	5	-			-	-		13	0.51
–1.5	2	2	2	6	6	2			-	-		20	0.62
–2.0	1	1	1	4	7	2			-	-		16	0.69
–2.5			-	1	2	4			-	-		7	0.89
–3.0			-	2	-	5			3	-		10	1.01
–3.5				1	-	-			1	-		2	0.95
–4.0				1	-	-			1	2		4	1.22
–4.5					2	-			1	-		3	0.97
–5.0						4			1	1	2	8	1.3
–5.5						-			-	2	-	2	1.5
–6.0						1	2	1	3		-	7	1.19
–6.5									1		-	1	1.3
–7.0											-	-	-
–7.5											2	2	1.8
–8.0											-	-	-
–8.5											-	-	-
–9.0											-	-	-
–9.5											-	-	-
–10.0											1	1	1.8
–10.5											-	-	-
–11.0											1	1	1.8
Total	8	7	4	16	22	18	2	1	11	5	6	100	0.87*
Mean RE	–1.06	–1.29	–1.50	–2.12	–1.90	–3.22	–6.0	–6.0	–4.59	–4.8	-7.8	-2.97**	R = 0.897

*Mean Log MAR Acuity of the total group
** Mean refractive error of the total group

Out of 42 cases taken to study discrepancy, 18 (43 %) cases of Group-A (control) showed no discrepancy either in the form of refractive error or visual acuity (Table 2). Group B constituted 14 (33 %) cases which showed a discrepancy in uncorrected visual acuity (Table 3) and Group-C (Test group) consisting of 10 (24 %) cases showed a discrepancy in refractive error, the UCVA being same (Table 4). Thus the total number of cases showing discrepancies in either form were 24 (57 %) in number, which constituted the prevalence of discrepancy (Table 5). It was seen that in Group-B, eyes with poorer vision had a greater mean axial length, a steeper mean anterior corneal curvature and also a deeper mean anterior chamber depth. (Table 3) In group-C, eyes with a higher mean refractive error also showed a greater mean axial length, a steeper mean anterior corneal curvature and a deeper mean anterior chamber depth (Table 4).

Table No. 2
Group-A: Showing no disparity

S.No.	Age/ Sex	Visual Acuity		Refractive Error (Diopters)		Axial Length (mm)		Anterior Corneal Curvature (D)		AC Depth (mm)	
		RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
1.	09 Y/M	6/9(+0.2)	6/9(+0.2)	-0.5	-0.5	23.45	23.56	42.80	42.75	3.62	3.66
2.	07 Y/F	6/9(+0.2)	6/9(+0.2)	-1.5	-1.5	22.78	22.61	44.5	43.5	3.40	3.88
3.	11 Y/F	6/12(+0.3)	6/12(+0.3)	-1.5	-1.5	23.47	23.63	39.75	40.25	2.54	3.13
4.	12 Y/M	6/12(+0.3)	6/12(+0.3)	-1.0	-1.0	22.19	22.12	44.25	44.23	2.49	2.58
5.	15 Y/M	6/24(+0.6)	6/24(+0.6)	-1.5	-1.5	23.24	23.06	42.875	43.625	3.73	3.47
6.	08 Y/M	6/24(+0.6)	6/24(+0.6)	-1.5	-1.5	22.17	22.19	46.5	46.5	3.58	3.54
7.	05 Y/M	6/24(+0.6)	6/24(+0.6)	-2.0	-2.0	21.77	21.89	46.875	47.375	2.95	3.02
8.	13 Y/M	6/36(+0.8)	6/36(+0.8)	-1.0	-1.0	23.97	24.14	44.0	44.0	3.69	3.81
9.	08 Y/M	6/36(+0.8)	6/36(+0.8)	-4.5	-4.5	26.12	25.73	41.625	41.750	3.58	3.25
10.	09 Y/M	6/36(+0.8)	6/36(+0.8)	-2.0	-2.0	24.09	24.03	44.375	44.125	3.36	3.73
11.	09 Y/M	6/60(+1.0)	6/60(+1.0)	-3.0	-3.0	24.11	24.09	43.25	43.25	2.98	3.36
12.	12 Y/M	6/60(+1.0)	6/60(+1.0)	-5.0	-5.0	24.39	24.37	42.75	43.125	3.32	3.25
13.	12 Y/M	6/60(+1.0)	6/60(+1.0)	-2.5	-2.5	24.46	24.77	42.75	42.75	3.06	3.62
14.	15 Y/M	3/60(+1.3)	3/60(+1.3)	-3.0	-3.0	24.17	23.35	42.75	43.375	3.66	2.95
15.	08 Y/M	2/60(+1.5)	2/60(+1.5)	-4.0	-4.0	23.96	24.52	46.0	46.0	3.58	3.77
16.	09 Y/M	2/60(+1.5)	2/60(+1.5)	-5.5	-5.5	24.92	24.75	44.50	44.50	3.58	3.47
17.	12 Y/F	1/60(+1.8)	1/60(+1.8)	-8.0	-8.0	25.75	26.24	43.0	43.125	3.02	3.69
18.	14 Y/F	1/60(+1.8)	1/60(+1.8)	-5.0	-5.0	24.92	25.52	43.375	43.625	2.95	3.62
Mean ± SD		0.90 ± 0.52	0.90 ± 0.52	-2.94 ±1.99	-2.94 ±1.99	23.88 ± 1.18	23.92 ± 1.25	43.66 ± 1.72	43.77 ± 1.65	3.28 ± 0.39	3.43 ± 0.35

Value in parenthesis denotes Log MAR Acuity

Table No. 3
Group-B: Showing disparity in visual acuity

S.No.	Age	UCVA		Refractive Error (Diopters)		Axial Length (mm)		Anterior Corneal Curvature (D)		AC Depth (mm)	
		Better Eye	Poor Eye	Better Eye	Poor Eye	Better Eye	Poor Eye	Better Eye	Poor Eye	Better Eye	Poor Eye
1.	14Y/M	6/9(+0.2)	6/12(+0.3)	-1.0	-1.0	22.36	22.77	44.75	44.75	3.06	3.06
2.	12Y/M	6/9(+0.2)	6/24(+0.6)	-2.0	-2.0	23.01	23.49	45.25	45.25	3.1	3.1
3.	10Y/M	6/18(+0.5)	6/36(+0.8)	-1.0	-1.0	23.77	23.92	42.00	41.50	3.47	3.49
4.	13Y/F	6/18(+0.5)	6/36(+0.8)	-0.5	-0.5	22.05	22.23	43.00	43.25	2.91	3.03
5.	07Y/M	6/18(+0.5)	6/36(+0.8)	-2.0	-2.0	23.33	23.88	43.25	43.25	3.28	3.38
6.	15Y/M	6/24(+0.6)	6/60(+1.0)	-2.0	-2.0	23.20	23.85	44.50	44.50	3.21	3.25
7.	12Y/M	6/24(+0.6)	6/60(+1.0)	-2.5	-2.5	23.40	23.81	44.25	44.25	2.84	2.94
8.	13Y/M	6/36(+0.8)	6/60(+1.0)	-2.5	-2.5	23.21	23.57	45.50	45.75	3.35	3.38
9.	07Y/M	6/18(+0.5)	6/60(+1.0)	-1.5	-1.5	23.43	24.07	43.25	43.50	3.26	3.26
10.	11Y/M	6/36(+0.8)	6/60(+1.0)	-1.5	-1.5	23.30	23.80	43.50	44.00	3.01	3.06
11.	15Y/F	6/36(+0.8)	6/60(+1.0)	-2.0	-2.0	22.45	22.95	45.50	45.50	3.45	3.15
12.	14Y/F	6/60(+1.0)	3/60(+1.3)	-3.0	-3.0	24.58	24.93	42.75	42.75	3.43	3.47
13.	12Y/M	5/60(+1.1)	3/60(+1.3)	-6.0	-6.0	25.10	25.79	43.25	43.50	3.06	3.07
14.	15Y/F	5/60(+1.1)	4/60(+1.2)	-6.0	-6.0	25.54	25.84	46.75	47.00	3.43	3.63
Mean ± SD		+0.66 ± 0.29	+0.94 ± 0.27	-2.39 ±1.66	-2.39 ±1.66	23.48 ±0.99	23.92 ±1.03	44.10 ±1.32	44.19 ±1.40	3.20 ±0.21	3.23 ±0.20

Value in parenthesis denotes Log MAR Acuity

Table No. 4
Group-C: Showing disparity in refractive error

S.No.	Age/ Sex	Refractive Error (RE) (Diopters)		Visual Acuity in Eyes		Axial Length (mm) in Eyes		Anterior Corneal Curvature (D) in Eyes		AC Depth (mm) in Eyes	
		Lower	Higher	Lower RE	Higher RE	Lower RE	Higher RE	Lower RE	Higher RE	Lower RE	Higher RE
1.	07 Y/M	-3.0	-4.0	6/24(+ 0.6)	6/24(+ 0.6)	24.36	24.72	44.75	44.75	2.78	2.88
2.	06 Y/M	-1.0	-1.5	6/36(+ 0.8)	6/36(+ 0.8)	23.34	23.78	43.50	43.75	2.82	2.86
3.	08 Y/M	-1.0	-1.5	6/36(+ 0.8)	6/36(+ 0.8)	23.65	23.94	43.75	43.25	3.62	3.62
4.	15 Y/M	-2.0	-2.5	6/36(+ 0.8)	6/36(+ 0.8)	24.59	24.81	41.75	41.75	3.30	3.15
5.	13 Y/M	-3.0	-5.0	6/60(+ 1.0)	6/60(+ 1.0)	24.43	25.01	42.00	43.00	2.87	2.88
6.	11 Y/F	-5.0	-6.0	6/60(+ 1.0)	6/60(+ 1.0)	25.65	26.64	43.50	43.75	2.64	2.75
7.	12 Y/F	-4.5	-6.0	3/60(+ 1.3)	3/60(+ 1.3)	25.16	25.66	43.25	43.25	2.72	2.87
8.	14 Y/M	-3.5	-4.0	3/60(+ 1.3)	3/60(+ 1.3)	25.03	25.29	42.25	42.50	3.40	3.55
9.	10 Y/M	-5.0	-6.0	3/60(+ 1.3)	3/60(+ 1.3)	25.32	25.85	43.25	43.25	3.40	3.44
10.	13 Y/M	-10.0	-11.0	1/60(+ 1.8)	1/60(+ 1.8)	24.64	25.23	43.25	44.25	3.26	3.26
Mean ± SD		-3.80 ±2.62	-4.75D ± 2.81	11.61 ±7.37	11.61 ±7.37	24.62 ±0.72	25.10 ±0.86	43.12 ±0.90	43.35 ±0.85	3.09 ±0.35	3.12 ±0.32

Value in parenthesis denotes Log MAR Acuity

TABLE No. 5
Prevalence of Disparity

	Group A	Group B	Group C	Total
Number of Cases	18 (43%)	14 (33%)	10 (24%)	42
Prevalence of disparity	0	14 (100%)	10 (100%)	24 (57%)

On comparing the results, the difference in discrepancies observed in UCVA between the two eyes in group B and that of refractive error in group C was found to be highly significant (p value = < 0.001). Also the difference between mean axial length in the two eyes of group B and group C was significant at 0.01 level (2-tailed). However, the differences between the mean anterior corneal curvature (p value = >0.05) and the mean anterior chamber depth (p value = >0.05) in the two eyes of both the groups were found to be statistically insignificant (Table 6 & Table7).

Table No. 6
Statistical Comparison in Group B (Test)

	Eyes with better UCVA	Eyes with poor UCVA	P value (paired t-test)
Mean UCVA	+ 0.66 + 0.29	+ 0.94 + 0.27	<0.001
Mean Axial Length (mm)	23.48 ± 0.99	23.92 ±1.03	<0.001
Mean Anterior Corneal Curvature (D)	44.10 ±1.32	44.19 ±1.40	0.2
Mean Anterior Chamber Depth (mm)	3.20 ±0.21	3.23 ± 0.20	0.3

Table No. 7
Statistical Comparison in Group C (Test)

	Eyes with lower refractive error	Eyes with higher refractive error	P value (paired t-test)
Mean Refractive error (D)	-3.80 + 2.62	-4.75D + 2.81	<0.001
Mean Axial Length (mm)	24.62 + 0.72	25.10 + 0.86	<0.001
Mean Anterior Corneal Curvature (D)	43.12 + 0.90	43.35 + 0.85	0.16
Mean Anterior Chamber Depth (mm)	3.09 + 0.35	3.12 + 0.32	0.15

Discussion

Various studies have been conducted in the past to study the relationship between visual acuity and refractive error in myopia. Hirsch, in a study of 64 eyes, with degrees of myopia varying from – 0.5 D to 13.50 D, gave a coefficient of correlation of 0.95 (Hirsch MJ, 1945). Crawford et al, in a study of 325 eyes, obtained a correlation ratio of 0.834 (Crawford et al 1945).

The correlation ratio is a statistical constant which indicates the strength of the connection between two variables and is used when the relationship is curvilinear, while the correlation coefficient is used in case of a linear relationship (Guilford JP, 1936). The value of correlation coefficient (0.897, p value< 0.001) in our study indicates a linear relationship between UCVA and refractive error in myopia. The studies in the past have also shown a linear relationship between the two. However, the association between these two variables was not a perfect one (Crawford et al 1945; Hirsch MJ, 1945). Studies have shown that the clinically-measured relation between refractive error and visual acuity can be variable, both between subjects within an investigation and between means of different investigations. Within one investigation, the data of Crawford et al (1945) shows an inter-subject variation of up to 7:1 in acuity for the same level of refractive error (Crawford et al 1945). The data of Hirsch shows a variation of 4:1 and those of Prince and Fry show a variation of 3:1 (Hirsch MJ, 1945; Prince & Fry, 1956). There could be many objective factors that may account for this variability. Some of these are target type, threshold level and light level. Other factors may be subject-dependent, such as pupil size, minimum angle of resolution and personality factors (Smith G, 1991; Atchison et al 1979).

It was seen in the present study that for a given visual acuity there was a wide range of refractive errors and correspondingly for a given refractive error there was a wide range of visual acuities. In fact the observations of this day-to-day variation in visual acuity measurements in relation to refractive errors have given the impetus for this study. For studying disparities between UCVA and myopia, we have preferred two eyes of the same subject to rule out the factor of variation in resolution among individual eyes. In order to try to explain these discrepancies encountered in our study, we have taken parameters like axial length, anterior corneal curvature and anterior chamber depth that could offer some explanation. On comparing these parameters statistically, it was found that axial length was significantly greater in eyes having poorer vision as well as in eyes with higher refractive error (p value< 0.001), which more than amply justifies this disparity. Many scientists have already shown by studying correlation between refraction and ocular biometry that refractive status is mainly dependent on axial length (Lo Pi et al 1996, Touzeau O et al 2003). But none of them have focused on the disparity between UCVA and refractive error in myopia and no none has proved the cause for it. Our study is unique in the sense that we have for the first time studied the visual and refractive error disparity in myopia and have also proved the cause for it.

Conclusion

Though there is a linear relationship between UCVA and myopia, yet an accurate prediction of uncorrected visual acuity cannot be made on the basis of the refractive error or vice-versa for any single individual, as there is a disparity either in the form of UCVA or refractive error in myopia. The reason as proven statistically in our study is increased axial length for both forms of disparity.

References

Atchison DA, Smith G, Efron N (1979). The effect of pupil size on visual acuity in uncorrected and corrected myopia. Am J Optom Physiol Opt; 56: 315-23.

Cass HD, Sonksen PM, Mc Conachie HR (1994). Developmental set back in severe visual impairment. Arch Dis Child; 78: 192-6.

Crawford JS, Shagass C, Pashby TJ (1945). Relationship between visual acuity and refractive error in myopia. Am J Ophthalmol; 28: 1220-5.

Dandone R, Dandone L (2001). Refractive error blindness. Bull World Health Organ; 79: 237-43.

Day S (1997). Normal and abnormal visual development. In: Taylor D, ed. Pediatric Ophthalmology. 2nd Ed. London; Blackwell Science: p13-28.

Ferris F L, Kassoff A, Bresnick GH, Bailey I (1982). New Visual Acuity Charts for Clinical Research. Am J of Ophthalmol; 94: 91-96.

Guilford JP (1936). Psychometric methods. New York, McGraw Hill.

Hirsch MJ (1945). Relation of visual acuity to myopia. Arch Ophthalmol; 34: 418-21.

Lo PI, Ho PC, Lau JT, Cheung AY, Goldschmidt E, Tso MO (1996). Relationship between myopia and optical components-a study among Chinese Hong Kong student population. Yan Ke Xue Bao; 12(3):121-5.

Morgan A, Young R, Narankhand B, Chen S, Cottrialli C, Hosking S (2006). Prevalence rate of myopia in school children in rural mongolia. Optometry and Vision Science; 86:53-56.

Ojaimi E, Rose KA, Morgan IG, Smith W, Martin FJ, Kifley A, Robaei D, Mitchell P (2005). Distribution of ocular biometric parameters and refraction in a population-based study of Australian children. Investigative Ophthalmology and Visual Science; 46:2748-2754.

Onal S, Toker E, Akingol Z, Arslan G, Ertan S, Turan C, Kaplan O (2007). Refractive errors of medical students in Turkey: One year follow-up of refraction and biometry. Optometry and Vision Science; 84:175-180.

Prince JH, Fry GA (1956). The effect of errors of refraction on visual acuity. Am J Optom Arch Am Acad Optom; 33: 353-73.

Rahi J S, Dezaleuv C (1998). Epidemiology of visual impairment in Britain. Arch Dis Child; 78: 381-86.

Smith G (1991). Relation between spherical refractive error and visual acuity. Optometry and vision science; 68 (8): 591-598.

Touzeau O, Allouch C, Borderie V, Kopito R, Laroche L (2003). Correlation between refraction and ocular biometry. J Fr Ophthalmol; 26: 355-63.

Source of support: nil. Conflict of interest: none