Repeatability and reproducibility of optical aberrations measure in normal eyes using a Shack – Hartmann Aberrometer

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PURPOSE

In the modern clinical investigation of the visual performances the careful analysis of the ocular aberrations has assumed a fundamental importance1.

Purpose of the present job is to appraise the repeatability and reproducibility of the measurement of the ocular aberrations obtained with a Shack – Hartmann Aberrometer, and particularly a Keratron ONDA (KO) produced by Optikon 2000 S.p.A. (Rome).

MATERILAS AND METHODS

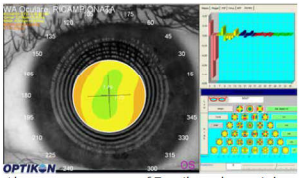
68 healthy (with no ocular pathologies and having not suffered surgical interventions) eyes with visual acuity in decimal notation equal to 1 or superior have been selected. Four consecutive measures have been obtained for each eye in a random way by two examiners with the KO.

For a 5mm pupil has been analyzed: Defocus and Astigmatism RMS, for lower orders; Coma RMS , Spherical Aberration, total higher (from 3rd to 7th) orders RMS and residual (without Coma and Spherical Aberration) higher orders RMS, for higher orders aberrations.

Statistical analysis has been performed using two different softwares: MedCalc for Windows, version 12.2.1.0 (MedCalc software, Mariakerke, Belgium) and Microsoft Excel 2007 (Microsoft Corporation, Redmond, WA, United States).

To compare the activities of the operators (reproducibility) the normal distribution of the data for the various aberrations has been first assed by the Kolmogorov-Smirnov test; then a parametric analysis using the Student t test in case of normality of the data has been performed, and the non-parametric Wilcoxon rank sum test where normality is not accepted. The repeatability of the operator has been evaluated using the following statistical parameters: Intrasubject Precision, Intrasubject Repeatability, Coefficient of Variation (CV), Intraclass Correlation Coefficient (ICC).

Starting from the analysis of variance (ANOVA for a single factor) of 4 consecutive measurements, we find the within subject standard deviation (Sw) through the square root of the variance. We subsequently plotted the data of the two operators with a scatter graph and the Bland-Altman plot.



Aberrometer output of Zernike polynomial representation for a 5mm pupil

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RESULTS

Both operators showed a high repeatability (ICC› 0.90) with respect to all parameters considered, except for higher orders for one operator and residual higher orders for both operators.

Statistical Coefficients	Defocus		Astigmatism RMS	
	Examiner A	Examiner B	Examiner A	Examiner B
Precision	0,353 µm	0,364 µm	0,066 µm	0,065 µm
Repeatability	1,176 µm	1,195 µm	0,508 µm	0,506 µm
CV	32,3%	35,1%	16,8%	16,9%
ICC	0,93	0,92	0,90	0,91

Repeatability of Defocus and Astigmatism RMS measures

Statistical Coefficients	Coma RMS		Spherical Aberration	
	Examiner A	Examiner B	Examiner A	Examiner B
Precision	0,034 µm	0,047 µm	0,032 µm	0,029 µm
Repeatability	0,365 µm	0,428 µm	0,355 µm	0,339 µm
CV	18,3%	23,9%	51,8%	47,1%
ICC	0,90	0,85	0,91	0,93

Repeatability of Coma RMS and Spherical Aberration measures

As it regards the reproducibility, the P value it is superior to 0,05 (then the error is not statistically significant) for all the aberrations excluding the Coma RMS, for the Student t test and the higher orders without Coma and Spherical Aberration for the not parametric Wilcoxon rank sum test.

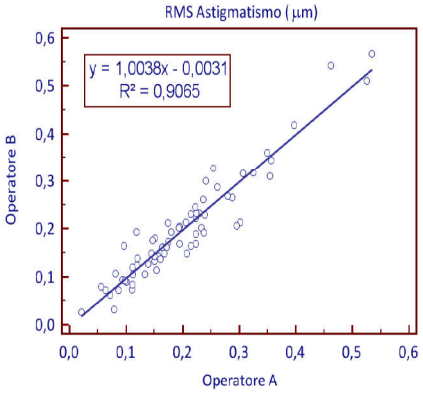
Student t test	Defocus	Astigm. RMS	Coma RMS	Sph Aberr
P	0,2813	0,5761	0,0298	0,9134

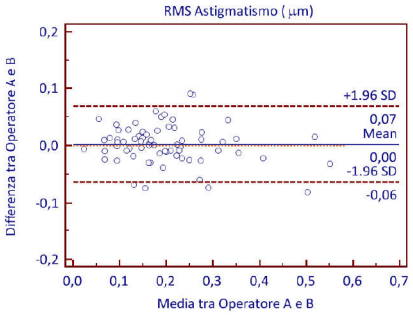
Reproducibility analysis by the parametric Student t test

Wilcoxon rank sum test	Total HO RMS	Residual HO RMS
P	0,0965	0,4634

Reproducibility analysis by the non parametric Wilcoxon rank sum test

As it regards the defocus, the astigmatism, the coma and the spherical aberration, the scatter graphs have shown angular coefficients and coefficients of determination R2 that points out an elevated correlation among the measures of the two examiners. The analysis according to Bland-Altman has confirmed this result showing as the 95% of the values of the differences among the measures are within the limits of the confidence interval of limit of agrement.





CONCLUSIONS AND POSSIBLE DEVELOPMENTS

Analysis of data shows, in agreement with similar studies in the literature 2-3, good intrapersonal repeatability and good reproducibility between different operators. The instrument has proven to meet the modern needs of clinical accuracy in the evaluation of aberrometric status of normal eyes. A future field of investigation could be the comparison inter eos of the sample pupils and of their diameters, to establish the correlation among these and the behavior of the dioptric ocular system.

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Contact Information

You can download the poster at http://www.irsoo.it/?????????.pdf

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