Reliability of Computer-Based Metamorphopsia Measurement in Macular Diseases

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Purpose

In this clinical observational study, the reliability of metamorphopsia measurement using a computer-based measuring method was determined in patients with macular diseases.

Methods

A quantitative metamorphopsia measurement with recording of magnitude d, eccentricity ε and area A was performed with the software A Metamorphopsia Detector® (app4eyes GmbH & Co. KG, Germany) [1].Participants were recruited in a private practice from May 2016 to August 2016 and signed informed consent according to the declaration of Helsinki prior to the study. A positive vote for this study has been received from the Ethics Commission of the University of Cologne. Inclusion criterion was macular disease documented by spectral domain optical coherence tomography (CirrusTM HD-OCT, Carl Zeiss Meditec).The exclusion criterion was best corrected visual acuity < 20/200. Metamorphopsia was measured twice one hour apart with appropriate correction. To determine the agreement of two repeated measurements the intraclass correlation coefficient (ICC) was calculated as a reliability measure [2 3,4].

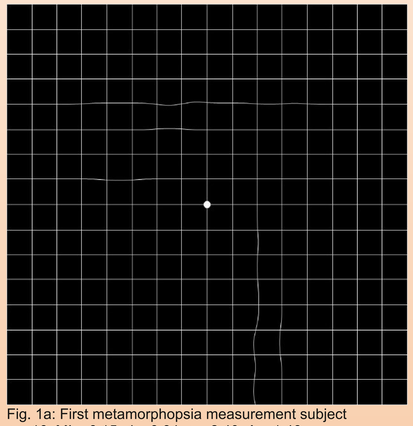

Fig. 1a: First metamorphopsia measurement subject no. 16: MI = 6.15, d = 3.84, ε = 2.40, A = 1.46

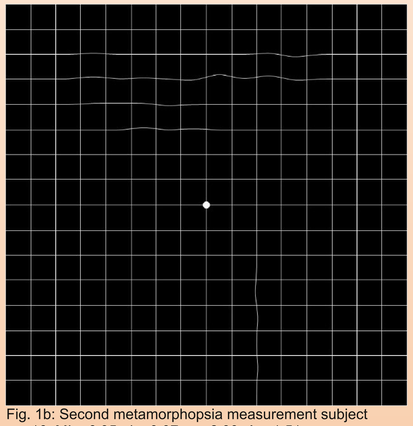

Fig. 1b: Second metamorphopsia measurement subject no. 16: MI = 6.35, d = 3.97, ε = 2.39, A = 1.51

Literature

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Commercial Relationships Disclosure

D. Claessens: Commercial Relationship: app4eyes GmbH & Co. KG: Code C (Consultant); app4eyes GmbH & Co.KG: Code P (Patent)
R. Krüger: Commercial Relationship: app4eyes GmbH & Co. KG: Code F (Financial Support); app4eyes GmbH & Co. KG: Code P (Patent)
A. K. Schuster: Commercial Relationship: Code N (None)

Results

36 eyes with macular diseases (36 patients, 15 women and 21 men, average age 70.5 ± 11.6 years, 19 right and 17 left eyes) were examined. The median visual acuity measured during the initial examination was 20/50.The diagnoses were intermediate age related macular degeneration (iAMD) in 7, late AMD in 15 (14 neovascular, 1 vitelliform), diseases of the vitreoretinal interface in 4, diabetic macular edema in 3, uveitic macular edema in 4, myopic macular edema Irvine Gass Syndrome and macular edema due to venous retinal occlusion in one eye respectively.

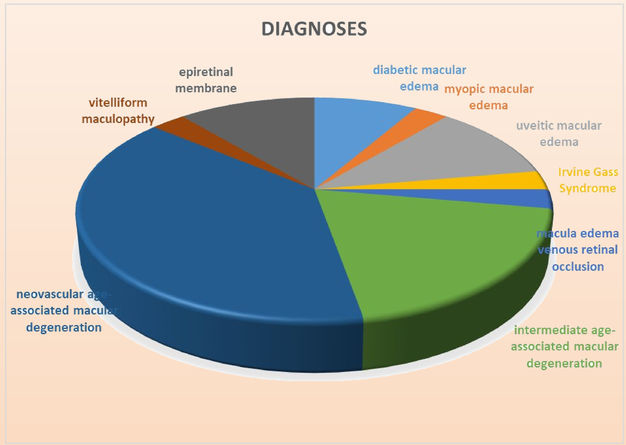

Fig. 2: Diagnoses of 36 eyes with macular diseases

Intraclass correlation coefficient ICC as a reliability measure

Index	ICC	95% Confidence Interval	p
Metamorphopsia Index MI	0.97	0.93; 0.98	<0.001
Subindex Magnitude d	0.95	0.91; 0.98	<0.001
Subindex Eccentricity ε	0.96	0.92; 0.98	<0.001
Subindex Area A	0.95	0.90; 0.97	<0.001

Tab. 1: Metamorphopsia Indices with intraclass correlation coefficient ICC and associated 95% confidence interval

Bland-Altman diagrams

Bland-Altman diagrams were prepared to look for any systematic bias and to visualize if the variability of the method was related to the value of the Metamorphopsia Index [6]. On the x-axis the mean value of metamorphopsia measurements 1 and 2 per patient is plotted. On the y-axis the difference of each pair of values is indicated (middle red bold dashed line). The adjacent dashed lines represent the 95% confidence interval and illustrate the magnitude of the systematic difference.The upper and lower limits of agreement (printed as blue bold dashed lines) are defined as the mean difference ± 1.96 standard deviation of differences.

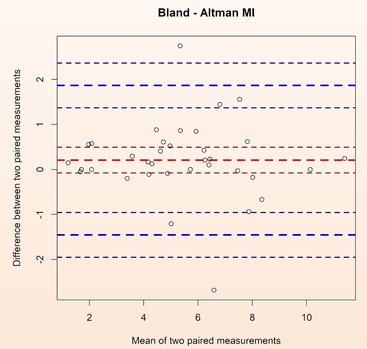

Fig. 3a: Bland-Altman plot for the Metamorphopsia Index MI
The mean difference for MI was 0.21, the lower limit of agreement was calculated as -1.45 and the upper limit of agreement was 1.87. In 95% the 2nd measurement supplied a value up to 1.45 below (lower limit of agreement) or up to 1.87 above (upper limit of agreement) the first measured value.

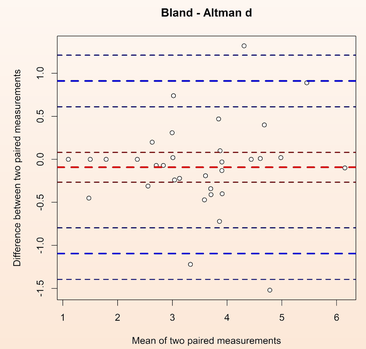

Fig. 3b: Bland-Altman plot for the magnitude d
The mean difference for the magnitude d was -0.09, the lower limit of agreement was -1.09 and the upper limit of agreement was 0.91.

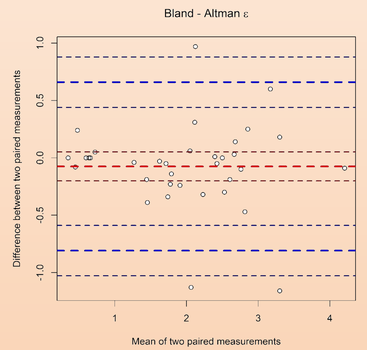

Fig. 3c: Bland-Altman plot for the eccentricity ε
The mean difference for the eccentricity ε was -0.08, the lower limit of agreement was -0.81 and the upper limit of agreement was 0.66.

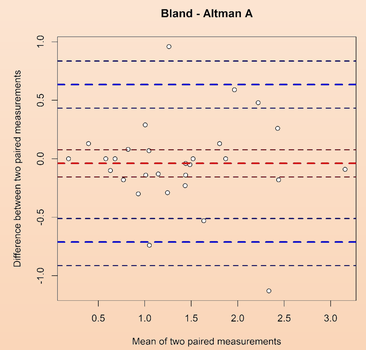

Fig. 3d: Bland-Altman plot for the area A
The mean difference for the area A was -0.04, the lower limit of agreement was -0.71 and the upper limit of agreement was 0.63.

Discussion

In this patient group, the Metamorphopsia Index and the parameters magnitude, eccentricity and area showed a high reliability: in 95 % of the cases, the second measurement provided a metamorphopsia value that did not differ to any clinically significant extent from the first measurement. As the line of equality (zero) was within the confidence intervals around the mean differences, there was no significant systematic difference between two paired measurements. The intraclass correlation coefficients for the indices MI, d, ε and A showed excellent judgement agreement. Comparability between different metamorphopsia measurement tools [7, 8] is impeded by different parameters measured, the size of the visual field examined, the disparity of reliability measures applied or by a lack of published data. [9, 10]. Visual acuity is a standardizable, however not comprehensive parameter for monitoring of macular disease often not in concordance with the patient's subjective perception [11] and with limited repeatability [12, 13]. If further studies confirm the superior reliability of metamorphopsia measurement with the method presented here compared to visual acuity, this might become a valuable and reproducible parameter in the monitoring of macular diseases with metamorphopsia.

Limitations

Cooperation of the patient has to be regarded as a bias. Due to lack of eye tracking fixation stability could not be documented. The ICC of the eccentricity, however indicates a good fixation stability.

Conclusion

In this study the metamorphopsia measurement with AMD - A Metamorphopsia Detector® showed reproducible metamorphopsia measurements in patients with maculopathies with high reliability and therefore represents a supplement for screening and monitoring of this patient-relevant endpoint in clinical routine as well as in clinical studies.