Three dimensions of quantifiable metamorphopsia measurement - do disease specific patterns exist?

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Purpose
The computer based program AMD - A Metamorphopsia Detector® is a tool to document 3 metamorphopsia aspects: amplitude of distortion (d), eccentricity (ε) and area (a). This study was performed to get an impression whether disease-specific patterns of those parameters may give a hint to the underlying pathology.

Material and Methods
The AMD - A Metamorphopsia Detector® program (patent pending) is based on the Amsler grid [1]. The patient straightens lines he monocularly perceives distorted [2] in a given distance depending on the screen size, so that the angle between two lines is 1°, controlled by ultrasound distance measurement. 3 dimensions of metamorphopsia are logarithmically measured and build a global index (GI). In 186 eyes of 166 patients (male 75%, female = 91%; age 36-97 years) best corrected visual acuity, Amsler Test, metamorphopsia measurement with AMD - A Metamorphopsia Detector® and SD-OCT (Cirrus, Zeiss) were performed. fluorescein angiography was recommended as performed by German guidelines and statements [3, 4]. Diagnoses were classified (Beckman classification [5]): neovascular age related macular degeneration (nAMD) = 25, intermediate AMD with large drusen (iAMD-drus) = 30, intermediate AMD with abnormalities of retinal pigment epithelium associated with at least medium drusen (iAMD-PRE) = 20, geographic atrophy = 9, retinal pigment detachment = 6, diabetic macular edema (DME) = 12 (4 with, 8 without neurosensory retinal detachment), epiretinal gliosis = 34, macular edema due to venous thrombosis (vTME) = 6, uveitis = 9 or myopia = 3 respectively, vitelliform maculopathy = 5, central serous chorioretinopathy (CSC) = 3, macular hole = 4. Prior to the study all patients signed informed consent according to the declaration of Helsinki/ Edinburgh.

Results
GLOBAL INDEX GI
Mean and median for GI was highest in nAMD. nAMD and vTME showed highest GI- and single dimension values.

3 DIMENSIONS OF METAMORPHOSIA
Median for amplitude (d) was highest in nAMD and in vitelliform maculopathy (both 4.14).
Median for eccentricity (ε) was highest in macular edema due to uveitis (ME uv) (2.98).
Median for area (a) was highest in vitelliform maculopathy (4.44) and in macular edema due to uveitis (ME uv) (2.30).
nAMD revealed higher values than intermediate AMD with drusen or RPE-abnormalities in all 3 subindicies.

CORRELATION OF SINGLE DIMENSION AND GLOBAL INDEX
Strongest correlation of single dimension and GI was found in nAMD for amplitude of distortion (d) (Pearson correlation coefficient ρ = 0.95), in AMD-PRE for eccentricity (ε) (ρ = 0.9) and in DME for area (a) (ρ = 0.97) demonstrating which single dimension contributed primarily to the global metamorphopsia index (GI).

LOCAL DEGREE OF DISTORTION
The smallest value for local degree of distortion (d/a) was found in vitelliform maculopathy (1.65), the highest in macular hole (3.98).
Local degree of distortion (d/a) was higher in intermediate AMD with large drusen (iAMD-drus) (d/a: median 2.38, median 2.33) than in intermediate AMD with abnormalities of retinal pigment epithelium (iAMD-PRE) (d/a: median 2.34, median 2.19) and in neovascular age related macular degeneration (nAMD): (d/a: median 2.43, median 2.04).

Conclusion
The AMD – A Metamorphopsia Detector® program provides quantitative evaluation of 3 dimensions of metamorphopsia as a patient relevant outcome [6]. Global Index, subindicies and local distortion could distinguish intermediate AMD with drusen (iAMD-drus) from intermediate AMD with abnormalities of retinal pigment epithelium (iAMD-PRE), neovascular AMD (nAMD) and RPE-detachment (fig. 1, 5, 6).

Discussion
In this cohort neovascular AMD, retinal pigment epithelial detachment and intermediate AMD with abnormalities of retinal pigment epithelium respectively differed from intermediate AMD with large drusen in global index GI, subindicies and local degree of distortion.

The fact that global index of neovascular AMD, retinal pigment epithelial detachment and intermediate AMD with abnormalities of retinal pigment epithelium respectively were significantly higher than intermediate AMD with large drusen could be an indicator that macular anatomical deterioration is accompanied by enhancement of metamorphopsia.

Different group sizes is a bias. Calculation of local degree of distortion (d/a) revealed higher mean and median values in intermediate AMD with large drusen (iAMD-drus) than in intermediate AMD with RPE-abnormalities (iAMD-PRE), RPE-detachment and neovascular AMD (nAMD) (Tab.3).

Higher local distortion values and lower GI values distinguished intermediate AMD with large drusen (iAMD-drus) in this study from neovascular AMD (nAMD), intermediate AMD with RPE-abnormalities (iAMD-PRE) and RPE-detachment. Increasing GI and decreasing d/a may therefore indicate the need for close-meshed controls. Data of a larger cohort may reveal if changes over time leading to retinal pigment epithelium abnormalities and finally macular edema are accompanied by increasing global index and/or subindex values and decreasing local distortion (d/a) values and might thus be an indicator for impending conversion to neovascular AMD.

Typical patterns of global index, single dimensions and amplitude peaks emerging from such a study could serve as a diagnostic hint.

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Notes:
3. Aretz H. et al. (2014). Distribution of subfoveal choroidal thickness and retinal layer thickness in normal eyes of different age groups, JAMA Ophthalmology 132:1405-1410

Literature
1. van den Bos P. et al. (2016). Local and global metamorphopsia patterns in age-related macular degeneration, Retina 36:236-243
5. van den Bos P. et al. (2014). Local and global metamorphopsia measurements in advanced age-related macular degeneration, JAMA Ophthalmology 132:1025-1033