Changes in macular structure and function overtime in patients with Diabetic Macular Oedema and good vision

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Introduction

The key factor in preventing vision-threatening diabetic eye disease is earliest possible diagnosis of DR and Diabetic Macular Oedema (DMO) with timely treatment. Current structural and functional endpoints in diabetic eye disease management may not have the sensitivity to pickup early pathology.

Multifocal pupillographic objective perimetry (**mfPOP**) is an objective non-contact method. Its function is based on anatomical and functional integrity of pupillary response system. The parameters like pupil size, constriction amplitude, time-to-peak and signal to noise ratio (SNR) are measured with mfPOP developed in conjunction with Konan Medical USA.

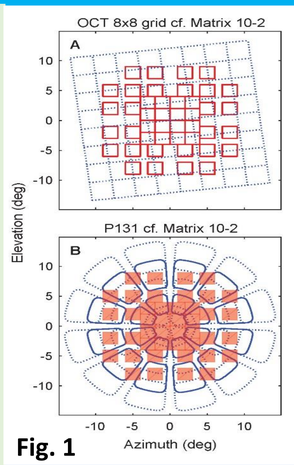


Fig. 1

Figure 1. Overlapping of the structural and functional measures. (A) Overlap of the Spectralis OCT 8×8 macular thickness grid of 3×3 degree regions, set at 7 degree tilt, with the Matrix 10-2 grid of 44 2×2degree square stimuli. The thickness map was flipped over first to fit the visual field projection. (B) Overlap of the 44 stimulus regions of the OFA test (extending to ± 15 degree eccentricity of visual field) with the 44 regions of Matrix 10-2.

Purpose

To investigate retinal sensitivity and delay utilising multifocal pupillographic objective perimetry (mfPOP) to identify eyes at risk of vision loss in early diabetic macular oedema (DMO).

Methods

We recruited 33 Type 2 Diabetes (T2D) patients aged 59.2 ± 10.5 years, 17 males (51.5%) each tested twice, 2 weeks apart. Patients were recruited from local optometry and ophthalmology practices in Canberra. This was a prospective longitudinal study, we followed up the DMO patients for three months, while those without DMO had six monthly exams for up to three years. Patients with other retinal, neurological, or pupillary disorders that would potentially affect pupillary function were excluded. To allow point-by-point comparisons macular 8×8 OCT thickness grid data, and mfPOP sensitivity and delay using the FDA-cleared Konan Medical objectiveField Analyser (OFA) were mapped onto the Matrix 10-2 pattern. We examined trends and correlations between thickness and functional measures using principal curve analysis. A generalised linear mixed-effects model (glme) determined which variables contributed to clinical diagnosis of DMO.

Results

The mean sensitivity difference compared to normal in T2D patients was negative and the mean delay difference positive indicating hyposensitivities and prolonged delays, both increasing with diabetes duration. Shorter diabetes duration produced peripheral hypersensitivity and shorter delays. OFA and Matrix values correlated well, with hypersensitivity shifting to hyposensitivity with increasing macular thickness. Outer macular thickness correlated with inner and outer OFA sensitivity and delay, all p<0.0012 in DMO and a median of p=0.001 for diabetic eyes without DMO. Inner and outer OFA delays were marginally correlated with Matrix sensitivity (p=0.052 to p=0.065). The tlme determined that outer thickness and OFA sensitivity (p=0.043), male gender (p=0.0313) and time in the study (p=0.001), contributed independently to the odds of a clinical diagnosis of DMO.

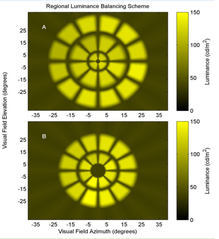


Figure 2. The 44 region per eye stimulus layout.

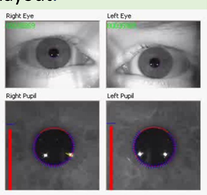
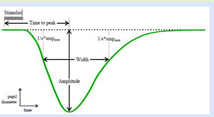


Figure 3. Operator's view of the pupil tracking & monitoring



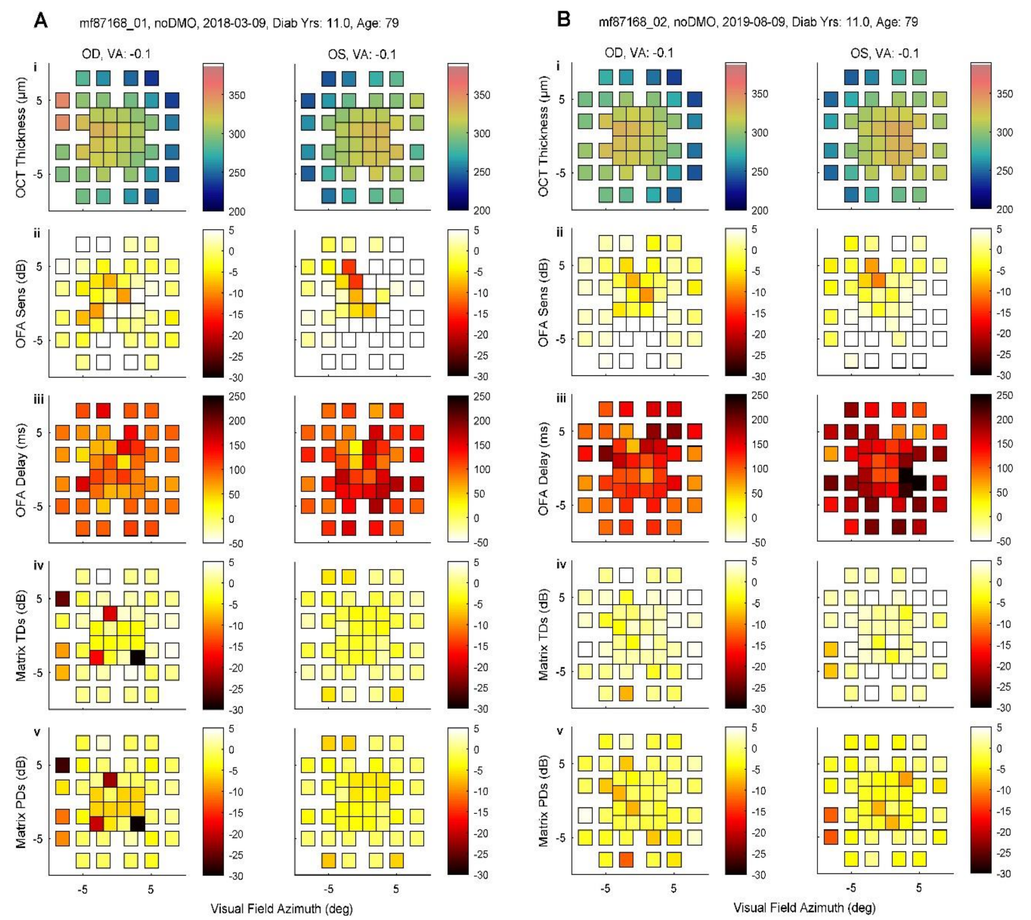
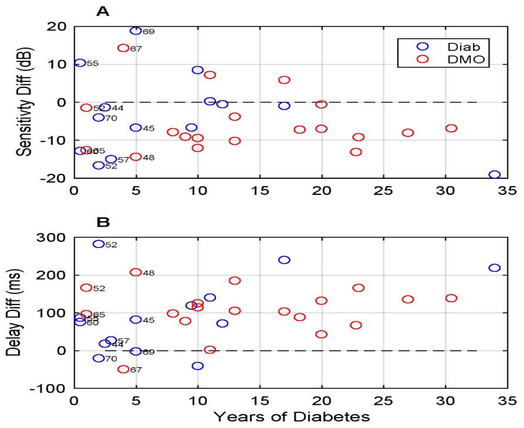


Figure 4. Illustration of data mapped to the 10-2 format for two visits 17 months apart (**A, B**) from a diabetic patient whose initial age was 79 years. The pairs of columns in A (initial visit) and B (17 months later) are for OD and OS. From top to bottom the rows of data show: OCT retinal thickness, OFA sensitivities and delays, and Matrix Total Deviations (TDs) and Pattern Deviations (PDs). The rows are also identified by the numerals i to v. **i**) The OCT data are very consistent between visits. **ii**) The OFA sensitivities (OFA Sens) are consistent between visits with some superior loss and peripheral hypersensitivity. **iii)** Delays appear to have grown on the second visit, especially OS. **iv & v)** The Matrix TD and PD data are variable between visits. In this case the OFA showed more consistent sensitivity results than the Matrix 10-2 perimeter. Like the OFA the Matrix TDs showed some peripheral hypersensitivity.



	OCT	Odelay	Osens	Matrix
OCT	1	**0.315**	**-0.317**	-0.095
Odelay	**0.315**	1	**-0.585**	-0.169
Osens	**-0.317**	**-0.585**	1	-0.169
Matrix	-0.095	-0.169	0.135	1

Table 1. Correlation coefficients for thickness data from DMO patients and OFA sensitivity (Osens) and delay (Odelay) responses. Significant correlations in bold

Figure 5. OFA data showing the difference compared to normal in mean sensitivity and delays for the diabetes patients, with (red) and without (blue symbols) DMO. Some data points are labelled with the patient's age so that these patients can be identified in both plots. (**A**) Mean sensitivity differences are largely negative indicating lower sensitivity among the patients. The proportion of patients with this change increases with the duration of diabetes. In the earlier stages some subjects show retinal hypersensitivity. (**B**) Positive mean delay differences indicate that in most subjects, time-to-peak was prolonged relative to normal. The proportion of patients with prolonged delays increases with the duration of diabetes.

Conclusions

Mean sensitivities decreased, and mean delays increased in diabetic patients in later-stage disease. Macular thickness correlated significantly with OFA sensitivity and delay. Additional analysis showed that this was isolated to outer macular regions, inner macular thickness did not correlate significantly. Outer macular thickness and functional measures better indicated eye health in retinal disease than visual acuity or other central functional measures.

Disclosures:

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