Global flash multifocal electroretinogram (MOFO mfERG): Early detection of local functional changes and its correlations with optical coherence tomography & visual field tests in diabetic patients

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Aims
- To correlate MOFO mfERG with clinical functional and morphological tests
- To evaluate the functional changes of various types of diabetic retinopathy (DR) lesions by MOFO mfERG

Methods
Thirty-eight diabetic patients were examined: nine of them (aged 49.7± 6.4years) were free from diabetic retinopathy (DR) while twenty-nine of them (aged 49.8 ± 6.4years) had non-proliferative diabetic retinopathy (NPDR). Fourteen normal subjects (aged 49.4 ± 7.0years) were also recruited. Detailed eye examination was carried out for each subject. Subjects with systemic diseases other than diabetes mellitus or ocular disorders other than DR were excluded. Afterwards, each of them would undergo the Humphrey visual field (VF) assessment. The retinal nerve fiber layer thickness (RNFL) was measured by the Carl Zeiss optical coherence tomography (OCT). One eye of each subject was selected for the 103-hexagonal global flash multifocal electroretinogram (MOFO mfERG) assessment under high and low contrast (98% and 46%) conditions. 103 hexagons were grouped into thirty-five regions. Regional z-scores of mfERG responses (direct component DC and induced component IC) were calculated to study the functional changes among various types of DR lesions. The correlations of mfERG with the functional and morphological assessments would be studied.

Results
Individual mean z-scores of the DC and IC amplitudes had a moderate correlation with VF mean defect. For the DC amplitude z-score, the Pearson’s correlation r increased from 0.37 at high contrast to 0.47 at low contrast (p<0.01). For the IC amplitude z-score, the Pearson’s correlation r increased from 0.33 at high contrast to 0.45 at low contrast (p<0.02). No significant correlation was found between the mfERG implicit time with the VF mean defect (r=-0.02 to -0.27, p>0.05)

No significant correlation existed neither between mfERG amplitudes and the RNFL thickness (Pearson’s r=0 to 0.25, p>0.05) nor between mfERG implicit time and the RNFL thickness (r=-0.02 to 0.03, p>0.05).
After dividing the individual mfERG topography into thirty-five regions, there were totally 1278 regional samples collected. They were divided into five groups according to the severity of the regional retinal defects --- Gp 0: “control” (~38.3%); Gp 1: “No NPDR” (~43.8%); Gp 2: “Hard exudate only” (1.0%); Gp 3: “Outer retinal haemorrhage” (14.4%); Gp 4 “Inner retinal haemorrhage” (2.4%).

It was found that the regional DC and IC amplitudes were significantly reduced in the “No NPDR” groups when compared with the controls (p<0.05). The DC and IC amplitudes further reduced in the retinopathy groups (Group 2 to 4) when compared with the “No NPDR” group (p<0.05). The haemorrhage groups (Group 3 & 4) showed delayed DC and IC implicit time compared with the control and “No NPDR” group (p<0.05). No significant delay of implicit times was found between the control and “No NPDR”.

**Discussion and Conclusion**

In the routine eye examination, dilated fundus examination or mydriatic fundus photodocumentation is the common non-invasive method to detect the retinal anomalies for the diabetic patients (Carmichael TR, Carp GI, Welsh ND, Kalk WJ. Effective and accurate screening for diabetic retinopathy using a 60° mydriatic fundus camera. S Afr Med J. 2005; 95: 57-61). However, DR is only diagnosed when visible retinal defects are seen.

MOFO mfERG contains four video frames: a multifocal stimulus, a dark frame, a global flash and then another dark frame. The resultant waveform consists of two main components: the direct component (DC) and the induced component (IC). The DC response is predominantly from the outer retina with a few oscillatory wavelets contributed from the inner retina. While the IC is predominantly from the inner retina (Chu et al. Porcine global flash multifocal electroretinogram: Possible mechanisms for the glaucomatous changes in contrast response function. Vision research. 2008; 48: 1726-1734).

From the above mfERG findings, the reduction of the DC and IC amplitudes indicated that the diabetic patients suffered from retinal deterioration before the existence of the visible retinopathy signs. With the increase of the retinopathy severity, the retina would deteriorate to a greater extent.
There is well correlation between the mfERG assessment and the traditional functional test (VF) but poor with the morphological test (OCT). This demonstrated that the retinal adaptive impairment emerged before the morphological/ structural changes being detected by the common non-invasive methods. However, implicit time seems to be less sensitive in detecting the early functional changes in the “No NPDR” group. It might be due to the large inter-subject variability.

MOFO mfERG may provide a way for the early functional detection of the diabetic retina. This gives rise to a reflection to practitioners if there is any interventions can be taken in advance before the retinal function further deteriorates.

**Keywords:** multifocal electroretinogram, diabetic retinopathy, adaptation

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**Reference:**