

## Microperimetry biofeedback training in a patient with bilateral myopic macular degeneration with central scotoma

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Microperimetry-1 (MP-1) evaluation and MP-1 biofeedback training were done in a case of bilateral myopic macular degeneration with a central scotoma. Fixation behavior, location and stability of preferred retinal locus, eye movement speed, and mean sensitivity were assessed. The mean retinal sensitivities before, after and at 1-year after training in the right eye were 2.9 dB, 2.9 dB and 3.7 dB and in the left eye were 3.5 dB, 3.7 dB and 1.8 dB. The fixation point in the 2° gravitation circle, improved from 40% to 50% in the right eye and from 43% to 67% in the left eye. The average eye speed before, after and at 1-year after training in right eye were 0.19°/s, 0.26°/s and 0.25°/s and in left eye were 0.36°/s, 0.25°/s and 0.27°/s. Thus, biofeedback training using MP-1 can improve the visual function in patients with macular diseases and central scotoma.

**Key words:** Biofeedback, microperimetry, myopic choroidal neovascular membrane, preferred retinal locus, scotoma

Many of the end-stage macular diseases are characterized by the development of a central scotoma which, besides reducing reading speed, interferes with other visual functions: Space perception, contrast sensitivity, stereopsis and fixation stability.<sup>[1]</sup> Sunness *et al.* has showed that there is a preference for fixation with the scotoma.<sup>[2]</sup> With microperimetry-1 (MP-1) audio biofeedback training, patients with macular diseases who have lost foveal fixation capabilities are trained to relocate their preferred retinal locus (PRL) into an area with better sensitivity, called trained retinal locus (TRL).<sup>[3]</sup> This training to relocate the PRL can improve the fixation behavior and thereby the visual performance. We report changes in the fixation

characteristics and reading speed in a patient of myopic macular degeneration who underwent biofeedback (BFD) training.

### Case Report

A 59-year-old woman presented with central scotoma in both eyes since 1-year. She was a known case of myopic choroidal neovascular membrane (CNVM), which was treated with a photodynamic therapy and avastin anti-vascular endothelial growth factor intravitreal injection in both eyes 2 years ago. Her best corrected visual acuity was 20/100, N6 in both the eyes (refractive error: -15.00 Ds and -13.00 Ds for right and left eye respectively). On examination, she was diagnosed with myopic scarred CNVM. Following MP evaluation, she underwent MP-1 biofeedback training for 10 sessions each 10 min, on alternate days, for both eyes. A written informed consent was taken, and an approval from the institutional review board was obtained.

Distance visual acuity, near visual acuity, fixation, and MP tests were assessed again at the end of the biofeedback training (i.e., after 20 days) and at the follow-up, a year later. MP was repeated using the follow-up function, which automatically retested the patient in exactly the same locations.

The MP and fixation test were performed using MP-1 microperimeter (Nidek Technologies; Podua, Italy) in central 20° area. The stimulus attenuation ranged from 0 to 20 dB with Goldmann size III stimulus, the size of the target was kept 5° according to her visual acuity.

Each eye was assessed separately for fixation behavior, location and stability of the PRL, scotoma size and density and central light sensitivity.

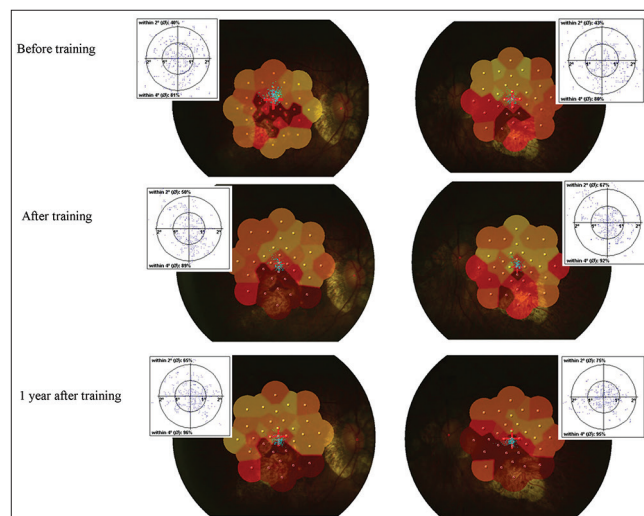
To assess the fixation stability, movements of the fundus were tracked during the examination while the patient gazed at the fixation target [Fig. 1]. The autotracking system calculated the horizontal and vertical shifts relative to a reference

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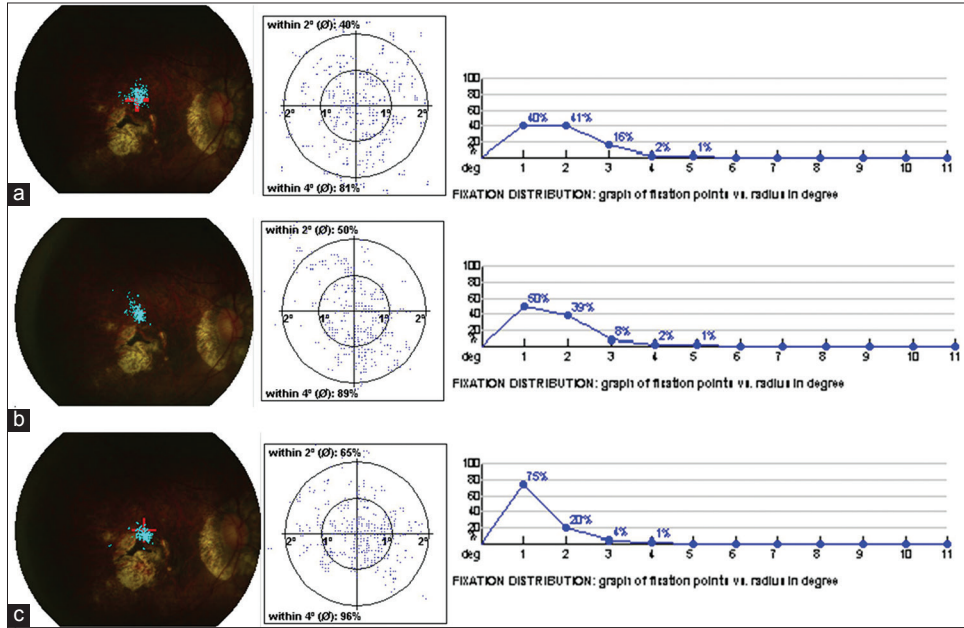
**Figure 1:** Microperimetry-1 image of color topography and stability of fixation at baseline, end of the biofeedback training and at 1-year follow-up.

frame and mapped the patient's eye movements during the examination. MP audio biofeedback training was performed by asking the patient to move her eyes according to an audio feedback, which advised whether the patient was getting closer to the desired final fixation position.

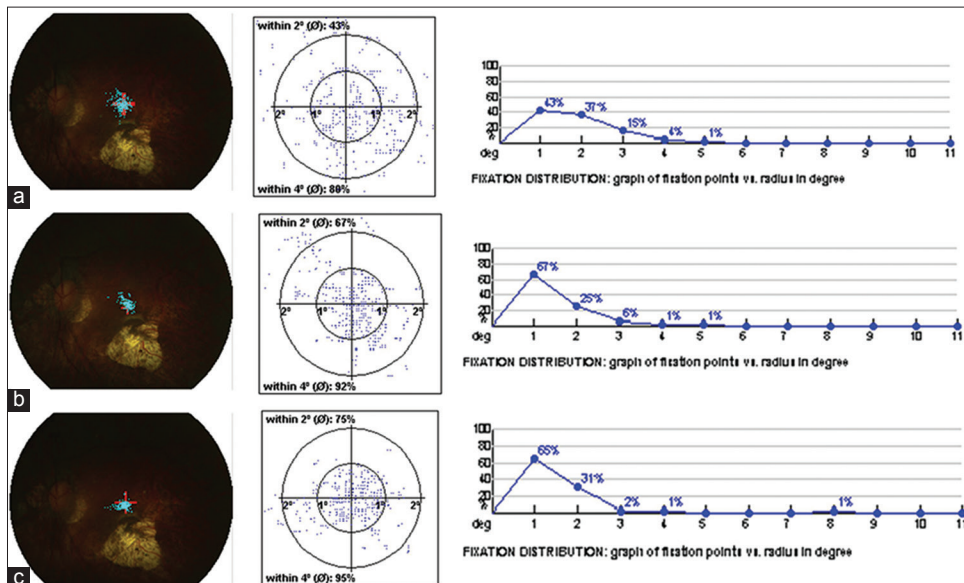
Fixation characteristics were taken as described by Fuji *et al.*,<sup>[4]</sup> the standard of central fixation was defined to approximate a 2° diameter (equals, 600 μ) circle centered on the fovea. The scotoma density was defined based on the threshold values: Normal function-threshold values of  $\leq 10$  dB; relative scotoma-threshold values of  $\leq 10$  dB and an absolute scotoma was present if no threshold could be seen.<sup>[5,6]</sup>

Best corrected visual acuity was 20/100 in both eyes before and after training and the same was maintained till the follow-up after a year. The mean retinal sensitivities before, after and at 1-year after training in the right eye were 2.9 dB, 2.9 dB and 3.7 dB and in the left eye were 3.5 dB, 3.7 dB and 1.8 dB.

The fixation point in the 2° gravitation circle, following biofeedback training improved from 40% to 50% in the right eye and from 43% to 67% in the left eye. The PRL, which was superior to the scotoma prior to and following the training, was maintained at the follow-up visit. The average eye speed, which was 0.19°/s before BFD training, changed to 0.26°/s following BFD training in the right eye and remained at 0.25°/s at the



**Figure 2:** Right eye: Fixation distribution: Graph of fixation points versus radius in degree. (a) Fixation behavior in center 2° area 40% before training with average eye speed of 0.19°/s. (b) Fixation behavior in center 2° area 50% after biofeedback training with average eye speed of 0.26°/s. (c) Fixation behavior in center 2° area 65% at 1-year of follow-up training with average eye speed of 0.25°/s



**Figure 3:** Left eye: Fixation distribution: Graph of fixation points versus radius in degree. (a) Fixation behavior in center 2° area 43% before training with average eye speed of 0.38°/s. (b) Fixation behavior in center 2° area 67% after biofeedback training with average eye speed of 0.25°/s. (c) Fixation behavior in center 2° area 75% at 1-year follow-up with average eye speed of 0.27°/s

follow-up visit. The average eye speed reduced from 0.36°/s to 0.25°/s in the left eye following BFD training and remained at 0.27°/s at the follow-up visit [Figs. 2 and 3].

The fixation location was predominantly eccentric in the right eye before training; it was poor central following BFD training and was maintained at 1-year follow-up. The fixation location was poor central in the left eye before training; it was poor central following BFD training and was predominantly central at 1-year follow-up.

## Discussion

This is the first report from India, which estimates the benefits of low vision rehabilitation using MP-1 BFD in macular pathology. This case showed good response after the BFD training, which was maintained at 1-year follow-up. Our results showed that new PRL (TRL) increased fixation stability as well as retinal sensitivity. No significant changes in the visual acuity, mean retinal sensitivity and speed of eye movement were seen. Nilsson *et al.* found an improvement in reading speed following eccentric viewing training demonstrated with scanning laser ophthalmoscopy microperimeter ( $9.0 \pm 5.8$ – $68.3 \pm 19.4$  with  $P < 0.001$ ).<sup>[7]</sup> Frennesson *et al.* used computer and video display based system for training eccentric viewing in macular degeneration with an absolute central scotoma, which showed a significant increase in reading speed.<sup>[8]</sup>

The BFD effect can be related to the brain's ability to perceive an efficient PRL for visual tasks. The audio feedback can help the brain to fix the TRL by increasing the attentional modulation. Sound perception increases the conscious attention of the patient, thereby facilitating the lock-in of the visual target and increasing the permanence time of the target itself on the retina. This mechanism probably facilitates stimuli transmission not only between intraretinal neurons, but also between the retina and brain where the highest degree of stimuli processing takes place, thereby supporting a "remapping phenomenon."<sup>[3]</sup>

In summary, this case demonstrated successful biofeedback training in macular pathology. Further studies are needed to

evaluate the usefulness of this technique in bilateral macular diseases.

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