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Scotoma simulation in healthy subjects

Sascha Klee; Dietmar Link; Stefanie Freitag; Steffen Rieger; Jens Haueisen

Author Affiliations & Notes

Sascha Klee
TU Ilmenau, Ilmenau, Germany

Dietmar Link
TU Ilmenau, Ilmenau, Germany

Stefanie Freitag
TU Ilmenau, Ilmenau, Germany

Steffen Rieger
TU Ilmenau, Ilmenau, Germany

Jens Haueisen
TU Ilmenau, Ilmenau, Germany

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Abstract

Purpose : Age-related macular degeneration (AMD) is one of the major causes of blindness in Europe and North America. Current vision rehabilitation approaches aim to relocate the retinal images away from the scotoma towards the peripheral retina and/or to adjust their size. There are spectacle-based vision aids with/without relocation, head-worn electronic devices and also handheld and table top devices. The question, what is the best approach to attain the maximum visual ability

for AMD patients, is still open. It would be highly desirable to have a model for AMD in healthy volunteers that allows the detailed investigation of different approaches. In this work, we present a novel concept for simulating AMD-scotoma in healthy subjects using individually fitted occlusive contact lenses. We demonstrate the validity of this concept by presenting functional measurements of visual fields from 10 volunteers.

Methods : To define an optimal set of lens parameters including lens transmission, radius and the aperture of the opaque zone, we designed a model using optical modeling software (OpticStudio, Zemax, USA). The anatomical pupil was set as the system stop, and its diameter was changed according to Baer's formula. To adjust scotoma size, which is clearly affected by the pupil diameter, we built a new miniaturized full-field adaptation device based on a tube system (Qioptiq, Germany). The perceived scotoma at the retina was validated using 30-2 SITA automated perimetry (76 points, 30°) in 10 volunteers (7♂, 3♀; 27–43 years). Therefore, we covered the left eye of each volunteer with the individually fitted contact lens. Due to the opaque zone of the lens, the perimeter fixation task was conducted using the right eye, applying the adaptation device to the perimeter (Humphrey Analyzer II, Zeiss Meditec, Germany).

Results : The functional measurements revealed absolute scotomas in all 10 visual fields. Due to the contact lenses, the loss of contrast sensitivity ranged within 27 and 36 dB ($p<0.05$), and the scotoma localizations were nearly centered with respect to the macula (mean variation of 2.0±4.8° in the horizontal and 3.5±4.7° in the vertical position).

Conclusions : The presented concept for simulating AMD-scotoma in healthy subjects was successfully validated by functional measurements of visual fields. The visual fields of all 10 volunteers exhibited absolute

scotomas. Our new concept is suitable for further investigations of different AMD rehabilitation approaches.

This is an abstract that was submitted for the 2016 ARVO Annual Meeting, held in Seattle, Wash., May 1-5, 2016.