ORIGINAL ARTICLE

# Fixation pattern analysis with microperimetry in nystagmus patients

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## ABSTRACT • RÉSUMÉ

**Objective:** To assess the usefulness of microperimetry (MP) as an additional objective method for characterizing the fixation pattern in nystagmus.

**Design:** Prospective study.

**Participants:** Fifteen eyes of 8 subjects (age, 12–80 years) with nystagmus from the Lluís Alcanyís Foundation (University of Valencia, Spain) were included.

**Methods:** All patients had a comprehensive ophthalmologic examination including a microperimetric examination (MAIA, CenterVue, Padova, Italy). The following microperimetric parameters were evaluated: average threshold (AT), macular integrity index (MI), fixating points within a circle of 1° (P1) and 2° of radius (P2), bivariate contour ellipse area (BCEA) considering 63% and 95% of fixating points, and horizontal and vertical axes of that ellipse.

**Results:** In monocular conditions, 6 eyes showed a fixation classified as stable, 6 eyes showed a relatively unstable fixation, and 3 eyes showed an unstable fixation. Statistically significant differences were found between the horizontal and vertical components of movement ($p = 0.001$), as well as in their ranges ($p < 0.001$). Intereye comparison showed differences between eyes in some subjects, but only statistically significant differences were found in the fixation coordinates X and Y ($p < 0.001$). No significant intereye differences were found between microperimetric parameters. Between monocular and binocular conditions, statistically significant differences in the X and Y coordinates were found in all eyes ($p < 0.02$) except one. No significant differences were found between MP parameters for monocular or binocular conditions. Strong correlations of corrected distance visual acuity (CDVA) with AT ($r = 0.812$, $p = 0.014$), MI ($r = –0.812$, $p = 0.014$), P1 ($r = 0.729$, $p = 0.002$), horizontal diameter of BCEA ($r = –0.700$, $p = 0.004$), and X range ($r = –0.722$, $p = 0.005$) were found.

**Conclusions:** MP seems to be a useful technology for the characterization of the fixation pattern in nystagmus, which seems to be related to the level of visual acuity achieved by the patient.

**Objet :** Évaluer l'utilité de la micropérimétrie comme méthode objective additionnelle pour la caractérisation du modèle de fixation chez des patients souffrant de nystagmus.

**Méthodes :** Étude prospective portant sur 15 yeux de 8 sujets (âges: de 12 à 80 ans) souffrant de nystagmus (Lluís Alcanyís Foundation, Université de Valence, Espagne). Tous les patients ont subi un examen ophtalmologique complet incluant une micropérimétrie (MAIA, Centervue). Les paramètres micropérimétriques suivants ont été évalués : le seuil moyen (SM), l'intégrité maculaire (IM), les points de fixation dans un cercle de 1° (P1) et de 2° de rayon (P2), l'aire de l'ellipse bi-courbe (BCEA) en considérant 63 % et 95 % des points de fixation, et les axes horizontal et vertical de cette ellipse.

**Résultats :** En conditions monoculaires, 6 yeux présentaient une fixation classifiée comme stable, 6 yeux affichaient une fixation relativement instable et 3 yeux présentaient une fixation instable. Des écarts statistiquement significatifs ont été constatés entre les composantes horizontale et verticale du mouvement ($p = 0,001$) et au niveau de leurs plages ($p < 0,001$). Des comparaisons interoculaires ont révélé des différences entre les yeux de certains sujets, mais on n'a noté des écarts statistiquement significatifs que pour les coordonnées de fixation X et Y ($p < 0,001$). Aucun écart interoculaire n'a été constaté pour les paramètres micropérimétriques. Entre les conditions monoculaires et les conditions binoculaires, des écarts statistiquement significatifs pour les coordonnées X et Y ont été constatés pour tous les yeux ($p < 0,02$) sauf un. Il n'y avait pas d'écarts significatifs entre les paramètres micropérimétriques en conditions monoculaires et en conditions binoculaires. On a constaté de fortes corrélations entre l'acuité visuelle corrigée à distance et le seuil moyen ($r = 0,812$, $p = 0,014$), l'intégrité maculaire ($r = -0,812$, $p = 0,014$), P1 ($r = 0,729$, $p = 0,002$), le diamètre horizontal de l'aire BCEA ($r = -0,700$, $p = 0,004$) et la plage X ($r = -0,722$, $p = 0,005$).

**Conclusions :** La micropérimétrie semble être une technologie utile pour la caractérisation du modèle de fixation chez les personnes souffrant de nystagmus, qui semble relié au niveau d'acuité visuelle du patient.


Nystagmus is an involuntary, rhythmic, and repetitive oscillation of eyes, usually characterized by bilateral and conjugate movements that can compromise the ability of foveal fixation. This condition has been classified through different nomenclatures according to the cause,[1] age of onset (congenital or acquired),[2] main component of movement (horizontal, vertical, or torsional), and regularity (pendular, or with accelerating/decelerating phases).[3] The quantification and registration of the physical characteristics of nystagmic movement is essential, because

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diagnosis and prognosis will depend in most of the cases on the waveforms of such movement.[4–8]

The methods of recording ocular movements in nystagmus[9–11] can be classified into 2 groups: electrophysiological methods based on bioelectrical properties of the eye, such as dynamic electro-oculography,[12–14] sclera search coil,[15] and functional magnetic resonance,[16] and oculographic methods, such as video-oculography[17] or infrared-oculography[18] that are based on the physical registration of eye positions over time. Although the selection of the method to use depends on many factors, oculographic methods are the most widely used in clinical practice because they are easy to perform and are not invasive.

Microperimetry (MP) is a technique that provides the measurement of the achromatic luminance threshold in the central region of the retina, with simultaneous visualization of the fundus image. This allows the analysis of the correlation of sensitivity data with the retinal status point by point.[19,20] Unlike conventional perimetry, MP incorporates the possibility of an absolute control over fixation because of the use of eye trackers, allowing not only to detect but also to correct fixation losses. This technique overcomes the limitations of conventional perimetry,[21] which is imprecise when the foveal function is compromised or central fixation does not exist. For this reason, the use of MP for the characterization of macular or perifoveal pathologies has become more common in clinical pactice.[22–26] Likewise, MP has been shown to be useful to evaluate the fixation pattern in nystagmus in 1 case.[27] The main aim of this study was to assess the usefulness of MP as an additional objective method for characterizing the fixation pattern in nystagmus.

## Methods

This was a prospective study that recruited patients from the Optometric Clinic of the Lluís Alcanyís Foundation (University of Valencia, Valencia, Spain), where the study was conducted. The patients were informed about the study and about their inclusion following the tenets of the Declaration of Helsinki of 1975 (as revised in Tokyo in 2004). Because the objective of this study was to evaluate the viability of MP in the characterization of nystagmus, the inclusion criterion was the presence of nystagmus of any type or cause, and with any associated pathology. No restriction was applied in terms of sex, ethnicity, or age.

All patients had a comprehensive ophthalmologic examination including retinal photography and macular optical coherence tomography (OCT-2000; Topcon Medical Systems, Oakland, N.J.). The best corrected visual acuity (BCVA) of each patient was measured in decimal scale using a Snellen chart projected on a screen at a distance of 6 m by means of a conventional projector (Topcon Medical Systems). None of the subjects had low vision; therefore, standard acuity tests were used.

The MP analysis was preceded by an analysis of binocularity, comprising the cover test and the 4-dot Worth test, both for distance and near vision, and stereopsis was measured by the TNO stereoscopic test. Ocular dominance was also assessed in these subjects through 3 methods[28,29]: sighting dominance (distance hole-in-the-card test), oculomotor asymmetry (near convergence test), and sensory dominance (red-filter test). In 3 consecutive measures, the eye that showed predominance was the same in all patients, so hereafter we will refer only to the term *dominance.*

All MP examinations were performed in the same session and by the same examiner to avoid a potential intersubject variability. None of subjects had previous experience with the MAIA instrument or another similar device. No trial run was performed before the first examination, but each subject was instructed on the technique. Both eyes of each subject were measured "monocularly," keeping the nonexamined eye closed. In addition, both eyes were analyzed separately, but keeping the nonexamined eye opened (binocular examination). All measurements were performed in a dark room after a period of adaptation of 2 minutes.

### Sensitivity examination

MP was performed using the microperimeter MAIA (CenterVue, Padova, Italy), which integrates the mechanism of the scanning laser ophthalmoscope with static perimetry. The mechanism of observation provides images of high quality even with pupil diameters of 2.5 mm. The maximum level of light of the perimetry is predetermined by the laser source, which in the case of the MAIA system can reach up to 318.47 cd/m.$^2$ This light appears in ranges of attenuation from 0 to 36 dB in steps of 1 dB. The background luminance is 1.27 cd/m.$^2$ The size of the stimulus is predetermined to be size III Goldmann-type, and each one is presented during a period of 200 milliseconds.

The measures of sensitivity were obtained using the option Expert Exam that consists of the use of a 4-2 staircase strategy of threshold in a static examination. The type of predetermined grid used for the perimetry was standard, with 37 projection positions distributed in 3 concentric circles (diameters 2°, 6°, and 10°) of 12 points each one and a central point (Fig. 1). After finishing the examination, the results of sensitivity in the different positions, as well as the average threshold (AT), are provided and compared with a normative database included in the instrument software that classifies eyes as normal, suspect, or anomalous.

Furthermore, the MAIA MP provides to the clinician an additional parameter to evaluate the status of the macula, the macular integrity index (MI).[30] This index is defined to identify the normal decrease in sensitivity