**Principle**

This exam allows the realization of a map of local ERG responses (mfERG).

The visual stimulator generates a matrix of 16 to 217 zones which are stimulated with independent sequences of flashes.

The global ERG response is recorded from a unique electrode. Local responses are obtained by computing the inverse correlation between this global ERG response and the stimulation sequence.

**Universal stimulator MonPackONE**

- very high luminance (up to 600 cd/m²) which allows to obtain high amplitude responses with optimal quality and reduced examination time
- control of the peripheral luminance (surrounding of the stimulation) which eliminates the contamination of ERG responses by rod photoreceptors,
- fixation monitoring with a high resolution video camera
- visual field covered by the stimulation: up to 30 degrees in eccentricity,
- stimulation distance (eye – screen distance): 30 cm,
- possibility to pulse the backlight LED illumination (with 1 ms resolution) to achieve high accuracy for the temporal analysis of responses,
- stimulation frequency (18 Hz) preserving the morphology of ERG responses by reducing temporal interferences.

**Stimulations**

The number of stimulation zones is comprised between 19 and 217. The typical recording time varies from 60 to 300 seconds for 61 stimulation zones, depending on the cooperation of the patient. The number of stimulated zones must be a compromise since, as this number increases, the accuracy of fixation and the recording time increase.

The stimulation zones have a hexagonal shape. Their size increases from the fovea to the periphery to obtain local responses of approximately constant amplitude (their amplitude depends on the density of photoreceptors).

Zones of uniform size are also available when the density of photoreceptors is abnormally distributed (central scotoma or eccentric fixation).

The length of stimulation sequences is optimized as a function of the number of stimulation zones to eliminate response contamination and keep the examination time as short as possible.
**Electrodes**

The best responses are usually obtained with scleral lenses, provided that they do not alter the optical quality of the retinal image. Other electrodes such as DTL fiber, HK loop or gold foil can also be used.

**Optical correction**

An accurate correction of refractive errors is important to obtain results of "good" quality.

Metrovision recommends the use of its set of « large field » eye glasses (55 mm in diameter) to avoid masking artifacts of the peripheral visual field.

**Fixation monitoring**

The patient’s fixation is stimulated by the presentation in the center of the fixation area of a small pattern which changes orientation in a pseudo random way.

The patient is asked to press a button every time the pattern orientation changes.

The high resolution video camera also allows an accurate control of fixation by the operator.

As an option, Metrovision proposes an automated fixation control which uses the image of the eye to automatically measure in real time the eye movements and pupil size and reject the responses in case of movement or eye blink.

**Map of local responses**

Le programme visualise en cours d’examen les réponses locales avec une identification automatique des pics N1, P1 et N2 de chaque réponse.

La qualité des résultats est évaluée en cours d’examen par le calcul du niveau de bruit du signal et par l’affichage de l’évolution du signal sur toute la durée de l’examen (ligne de base).

In the example hereby, the base line appears very unstable at the beginning of the exam, which is frequently due to eye movements, eye blinks or electrode instability.

After about 30 seconds, the baseline becomes stable and the noise level (3.5 uV) indicates that the quality of result is sufficient for a valid interpretation.

**2D and 3D maps**

The operator can display 2D and 3D interpolated maps of the amplitude and implicit time of the N1, P1 and N2 peaks of the local responses.
**Zone and ring ratio analysis**

The zone analysis allows the comparison of the average of responses within given zones. Responses can be grouped by rings (as a function of eccentricity relative to the fovea), by quadrants or by zones defined by the operator.

**Ring analysis**

**Quadrant analysis**

**Quantitative indexes – Normal data base**

The results from the zone analysis are compared to an age corrected data base which includes more than 100 normal subjects from several clinical centers. Quantitative measurements of amplitude and implicit times outside the normal range are immediately outlined with a color indicating the statistical significance of the alteration.

In addition, when the periphery is found normal, the program computes the amplitude ratio of the central responses to the peripheral responses, which is found to improve the detection of alterations of central responses.

It also calculates the ratio of the P1 to N1 amplitudes to distinguish between alterations of photoreceptors and alterations of the inner layers of the retina.

**Analysis of 2nd order kernel**

The analysis of 2nd order kernel is used to analyze temporal interaction between the responses of successive stimuli. It is available on all procedures.

However, the default tests are using a slow stimulation rate of 17 Hz which is designed to obtain a response similar to the “classic” photopic ERG waveform by minimizing temporal interactions between stimuli responses.

As a result of this reduced temporal interaction, the amplitude of the 2nd kernel is very small.

For this reason, 2nd order kernel responses are obtained by using specific procedures with a faster stimulation rate of 40 Hz minimum.
Comparison with the eye fundus

This analysis allows the superposition of the map of local mfERG responses over the image of the eye fundus of the patient. The image of the eye fundus is imported as an image file either through the computer network or by USB key, CDROM etc. The operator identifies by a simple click the position of the fovea and papilla and the program automatically performs the scaling and repositioning the eye fundus image.

Follow-up analysis

This analysis evaluates the evolution of mfERG results over several successive exams performed on the same patient. The program searches within the result data base all the results from the patient. It computes a map showing the rate of change of the amplitudes of the local responses over the last exams. The graphic shows in red color the areas where amplitudes are deteriorating and in green color where they are improving.

Clinical applications

Multifocal ERG is clinically useful in a large number of pathologies of the macula as it can point out local scotoma and local islands of vision which cannot be detected by standard ganzfeld ERG exams.

Recent references