CHAPTER 4
KEY EXAMINATION PARAMETERS

FIXED EXAMINATION PARAMETERS

Perimetric testing must be as standardized as possible, in order to allow comparisons over time and across different eye care providing offices. Therefore, many examination parameters are fixed by the perimeter used and are not specifically selected by the user of the perimeter. These fixed parameters typically include background color and luminance, maximum stimulus luminance and stimulus duration.

Different perimeter models use different fixed settings. Therefore, when switching from one device to another, it is important to consider their influence on the perimetric results. Chapter 12 provides an overview of the most common differences between devices and provides practical advice on how to successfully master the transition.

For the sake of completeness, a summary of the most essential fixed examination parameters of current Octopus perimeters and the rationales behind them is provided in Box 4A. Note that the settings presented below apply to Standard Automated Perimetry. In special situations, other fixed examination parameters are chosen. They are discussed in the respective chapters.

**BOX 4A**

**FIXED EXAMINATION PARAMETERS**

**BACKGROUND INTENSITY AND COLOR**

Background luminance (i.e., the reflected light intensity of the background) determines the contrast between the stimulus presented and the background, and thus has a considerable influence on stimulus perception. To achieve comparable test results, it must be kept constant.

The ideal background luminance of a perimeter should not be too bright, in order to allow display of very dim stimuli for a large dynamic testing range. Neither should it be too dark, to avoid time-consuming dark adaptation of the eye. It should stimulate selected cell types.

The standard background luminance of current Octopus models consists of white light with a luminance of 31.4 cd/m², which equals 10 cd/m². This luminance level is at the low end of photopic vision (i.e., the visual system used in normal daylight conditions) and does not require time for dark adaptation, but still provides a high dynamic testing range. White light is used because it is detected by all cell types in the retina and is therefore non-selective.

**MAXIMUM STIMULUS LUMINANCE**

As seen in Chapter 2, the maximum stimulus luminance (i.e., the maximum stimulus intensity) of a perimeter defines the luminance associated with 0 dB on the decibel scale. It is also part of the formula to calculate a decibel value from the stimulus luminance. If the maximum stimulus luminance were to change, then the whole decibel scale would shift, so it must be kept constant for comparable results to be achieved.

In order to offer a large dynamic testing range from normal to impaired vision, the maximum stimulus intensity value should be as high as possible. However, when the maximum stimulus intensity is
too high, a part of it will be reflected from the back of the eye (stray light) and will then be detected by neighboring cells, which will produce inaccurate test results. Empirically, a maximum stimulus luminance of 4,000 asb has been shown to offer a large dynamic range, while minimizing stray light effects.\footnote{\textsuperscript{1,2}}

**STIMULUS DURATION**

In order to reduce fixation losses, the perimetric stimulus duration (i.e., exposure time) is kept below the reaction time of the human reflex of quick eye movements towards rapidly appearing stimulus (i.e., saccadic eye movement). As the reaction time of the saccadic eye movement is around 200 ms, the stimulus duration should be shorter, but still sufficiently long to be seen. For that reason, Octopus perimeters use a standard stimulus duration of 100 ms.

**PATIENT-SPECIFIC EXAMINATION PARAMETERS**

As described in Chapter 2, there is always a trade-off between testing time and accuracy in perimetric examinations. In this respect, it is very important to maximize the clinically relevant information, while at the same time minimizing test duration. As perimetry has a wide range of applications, there is no "one parameter fits all" approach for all situations. Each Octopus perimeter thus contains a library of standardized examination parameters from which the optimum set can be chosen for each patient. These patient-specific examination parameters thus have to be selected for every patient.

In essence, there are four essential questions each clinician must answer, in the order shown below, prior to ordering a perimetric test:

1. Which **type of perimetry** should be used: static or kinetic perimetry?
2. Which **type of stimulus** should be used: standard white-on-white, function-specific or low-vision?
3. Which **test pattern** should be used?
4. Which **test strategy** should be used?

The first two questions are typically easy to answer. Indeed, static and standard perimetry are indicated for the needs of patients in most clinical practices and are by far the most commonly used types of perimetry. With regard to test strategy and test pattern, various selections are commonly employed, and these decisions must be made individually.

**TYPE OF PERIMETRY: STATIC OR KINETIC PERIMETRY**

**STATIC PERIMETRY**

For reasons of simplification, so far this book has concentrated on static perimetry. In static perimetry, stimuli of varying luminance levels are used to determine visual sensitivity thresholds at a specified number of fixed locations (\textbf{FIG 4-1A}). With this type of perimetry, it is possible to detect small changes in sensitivity thresholds with relatively high accuracy. For this reason, static perimetry is the standard for slowly progressing diseases such as
Patient-specific examination parameters

As the majority of visual field tests are performed for glaucoma, static perimetry is the most commonly used type of perimetry today.

**KINETIC PERIMETRY**

Kinetic perimetry was the first quantitative method of performing visual field testing and is an alternative to static perimetry. In kinetic perimetry, moving stimuli of pre-determined light intensities are moved from non-seeing to seeing areas. The patient response then defines the visual field location of the specific light sensitivity threshold (Fig 4-1B).

**STATIC AND KINETIC PERIMETRY TESTING METHODS**

**A) STATIC PERIMETRY**

**B) KINETIC PERIMETRY**

**Fig 4-1** Both static and kinetic perimetry are designed to provide visual sensitivity thresholds that allow mapping the hill of vision of a patient. In static perimetry (A), stimuli of differing light intensity are shown at given locations, to determine the sensitivity threshold at those positions. In kinetic perimetry (B), a stimulus of a given light intensity is moved along the visual field (non-seeing to seeing), to determine the location of that sensitivity threshold.
After repeating this process for a specific stimulus size and intensity across the entire visual field, the visual sensitivity thresholds can be connected to form an isopter (line of equal sensitivity). An isopter marks the boundary between seeing and non-seeing around the hill of vision for a given stimulus size and intensity and is similar to an altitude line on a geographical map. Local regions of reduced sensitivity inside the isopter are identified in the same way and are called scotomas. **FIG 4-2** shows how static and kinetic perimetry results are displayed.

Since the patient can report seeing the stimulus at any location along the trajectory of the stimuli, kinetic perimetry provides high spatial resolution and fast testing over a large area. It is therefore beneficial for diseases affecting the periphery and sharp-edged defects and is frequently used to evaluate neurological diseases and peripheral retinal diseases. As moving stimuli are easier to see than non-moving ones in the periphery, kinetic perimetry is also often used for children and for patients with cognitive impairment or severe visual field loss. However, kinetic perimetry is currently not fully automated, making it more challenging in everyday use.

As the majority of visual field tests are performed to assess glaucoma and due to the ease of use of automation, static perimetry is by far the most commonly used type of perimetry today. For that reason, all of the following paragraphs and chapters focus on static perimetry, while kinetic perimetry will be discussed in depth in Chapter 11. The key differences between static and kinetic perimetry are summarized in **TABLE 4-1**.
### COMPARISON BETWEEN STATIC AND KINETIC PERIMETRY

<table>
<thead>
<tr>
<th></th>
<th>STATIC</th>
<th>KINETIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADVANTAGES</strong></td>
<td>Clinical gold standard</td>
<td>High spatial resolution</td>
</tr>
<tr>
<td></td>
<td>High precision sensitivity thresholds</td>
<td>Fast peripheral testing</td>
</tr>
<tr>
<td></td>
<td>Fully automated</td>
<td>Provides information about other visual functions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highly interactive, flexible and adaptable</td>
</tr>
<tr>
<td><strong>WHAT IT IS BEST AT DETECTING</strong></td>
<td>Small changes in sensitivity thresholds</td>
<td>Small changes in spatial extent of a defect</td>
</tr>
<tr>
<td></td>
<td>Changes in the central area</td>
<td>Peripheral changes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remaining vision in advanced diseases</td>
</tr>
<tr>
<td><strong>COMMON USES</strong></td>
<td>Glaucoma</td>
<td>Neuro-ophthalmological conditions</td>
</tr>
<tr>
<td></td>
<td>Macular diseases</td>
<td>Peripheral retina diseases</td>
</tr>
<tr>
<td></td>
<td>Visual ability testing</td>
<td>Low vision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Children</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Patient with cognitive impairment</td>
</tr>
</tbody>
</table>

### STIMULUS TYPE: STANDARD OR NON-CONVENTIONAL

#### STANDARD WHITE-ON-WHITE PERIMETRY

The standard perimetric stimulus is white on a white background, and this type of perimetry is commonly referred to as white-on-white perimetry, or Standard Automated Perimetry (SAP).

The white color stimulus offers the advantage of stimulating all different retinal cell types. As a result, white light allows visual field testing from early to advanced disease (i.e., it offers a large dynamic testing range). By convention, the standard stimulus used is round, with a diameter of 0.43°, which is also the Goldmann stimulus size III, based on the definition of Professor Hans Goldmann. For more information on Goldmann stimulus sizes, refer to BOX 4B.
**FUNCTION-SPECIFIC PERIMETRY**

Function-specific perimetry uses different stimulus types to stimulate different visual functions (e.g., motion, or color vision), but they all have the same purpose: measuring a subset of the visual system individually, to get more sensitive responses for early disease detection. Different Octopus perimeter models offer different function-specific stimuli (*FIG 4-3*): a blue stimulus on a yellow background (Short-Wavelength Automated Perimetry, or SWAP); a white flickering stimulus on a white background (Flicker Perimetry); or a pulsating stimulus with concentric rings changing in both spatial resolution and contrast (Pulsar Perimetry). They are described in more detail in Chapter 10.

*FIGURE 4-3* Stimuli used in function-specific perimetry from left to right: Short Wavelength Automated Perimetry (SWAP), Flicker Perimetry and Pulsar Perimetry.
PERIMETRY FOR LOW VISION

There is a limit to the visibility of the standard size III white perimetric stimulus in patients with significantly impaired visual sensitivity. In order to increase the dynamic range into the low vision region and to make the stimulus more visible to these patients, the Goldmann stimulus size V is typically used, instead of the standard size III. It is 16 times larger in area and is therefore more detectable. Chapter 10 provides more information about stimulus size V.

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>STANDARD</th>
<th>FUNCTION-SPECIFIC</th>
<th>LOW VISION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clinical standard</td>
<td>Earlier detection in some patients</td>
<td>Better visibility for patients with significant visual field loss</td>
</tr>
<tr>
<td></td>
<td>White-on-white, stimulus III</td>
<td>Provides information about other visual functions</td>
<td></td>
</tr>
<tr>
<td>WHAT IT IS BEST AT DETECTING</td>
<td>Follow-up of a disease from early to late stage</td>
<td>Early loss in some patients</td>
<td>Advanced visual field loss</td>
</tr>
<tr>
<td>COMMON USES</td>
<td>Glaucoma</td>
<td>Confirm defects observed on standard perimetry</td>
<td>Advanced glaucoma or other ocular or neurological diseases</td>
</tr>
<tr>
<td></td>
<td>Macular diseases</td>
<td>Identify defects in glaucoma suspects who do not show defects on standard perimetry</td>
<td></td>
</tr>
</tbody>
</table>

Table 4-2: Overview of different stimulus types
TEST PATTERN

In clinical practice, patients can sometimes become tired quickly during perimetric testing, which significantly limits the number of test locations that can be reliably tested.3-6 A reasonably dense grid of test locations, covering the entire visual field with 2° spacing, would require around 4,800 size III stimuli, and a grid with 6° spacing would require approximately 550 test locations. A very rough grid with 10° spacing between the stimuli would require approximately 190 test locations, but would be highly inaccurate, as there would be only 5 test points in the central 10° of vision, which is an important area for visual functions such as reading and identifying objects (FIG 4-4).

ILLUSTRATION OF THE LOW SPATIAL RESOLUTION OF PERIMETRIC TESTING

In order to maximize perimetric information and minimize test duration, a test pattern should be chosen with a high density of test locations in the area of high interest and a low density of test locations in areas of low interest (FIG 4-5). For that reason, Octopus perimeters offer a large library of testing patterns for common perimetric applications.

The most commonly used test patterns available on the Octopus perimeter and the rationale for which to select are described in depth in Chapter 5.
Patient-specific examination parameters

FIGURE 4-5 Examples of test patterns for various clinical perimetric applications are presented. Each pattern maximizes the relevant information for that clinical situation, while minimizing the test duration by only evaluating the most relevant areas. (A) The G-pattern for glaucoma tests within 30° at locations that follow the retinal nerve fibre bundle patterns. (B) The M-pattern for the macula tests within the central 10°. (C) The Esterman tests binocularly for visual fitness to drive (120° horizontally and 60° vertically). (D) The Ptosis test pattern only evaluates the upper hemifield along common eyelid locations.
TEST STRATEGY

For the detection and follow-up of a disease, the sensitivity thresholds should be determined with high accuracy. However, in clinical practice, even very cooperative and reliable patients experience fatigue, which limits the number of stimulus luminance levels that can be presented during a perimetric test. If we were to sample the entire range in steps of 1 dB, from 0 dB (maximum stimulus luminance) to 32 dB (approximate foveal sensitivity threshold of a 20-year-old on the Octopus 900), 32 stimuli would have to be presented at one test location. Performing the same procedure in 2 dB steps would require 16 stimuli, while 4 dB steps would still require the presentation of 8 stimuli (FIG 4-6).

Instead of using the strategy of increasing stimulus intensity step by step until the sensitivity threshold is reached, an efficient strategy is therefore needed that maximizes precision but minimizes test duration.

Octopus perimeters offer several test strategies with different trade-offs between test duration and accuracy for different clinical situations. Some strategies are quantitative, which means that they are used to determine a sensitivity threshold (FIG 4-7). Qualitative strategies are also offered in which the testing time is reduced, because they only assess whether stimuli are seen or unseen (FIG 4-8). Qualitative strategies are commonly used in legal visual ability evaluations, such as in the tests used to assess visual fitness to drive. Examples of a quantitative and a qualitative test strategy are given in FIG 4-7 and FIG 4-8, for the sake of illustration.

The most commonly used strategies available on the Octopus perimeter and the rationale for which strategy to select are described in depth in Chapter 6.
EXAMPLE OF A QUANTITATIVE STRATEGY

**QUANTITATIVE STRATEGY**

1. Sampling in large steps
2. Detailing within threshold zone

**FIGURE 4-7** Example of a quantitative thresholding strategy: The visual field is first scanned with stimuli with large steps in light intensity, in order to identify a suspected threshold zone. Once that zone has been identified, further testing inside that zone will allow for determination of an accurate threshold with minimal test duration.

EXAMPLE OF A QUALITATIVE STRATEGY

**QUALITATIVE STRATEGY**

**FIGURE 4-8** Example of a qualitative strategy: For visual driving ability, one stimulus is shown at the fixed stimulus intensity which is the minimum needed to drive safely. If a person sees that stimulus at a required number of test locations, this means that the person fulfills the visual field criteria to be able to drive.
REFERENCES


