Description of new EyeSuite visual field and trend analysis functions

Global Trend Graph
The trend graph indicates the normality range (95%) on top as grey band. Falling below that area means falling out of normality. A descending line corresponds with a worsening of the visual field.

The total scale is 25dB since in most countries, a Mean Defect MD of 20..25dB is considered legal blindness. A 15dB line represents seriously impaired vision. Progression should – if possible – be stopped before reaching this line. If the MD is reaches values beyond 25dB, the range is automatically extended to the theoretic maximum to show all data points.

Below the graph, the change rate, the amount of fluctuation and their statistical significance are given.

**Progression rate**
The progression rate (mathematically slope) is calculated in dB per year, allowing to judge how aggressive the disease shall be treated. This follows the recommendation of various glaucoma societies, based on a publication of Chauhan et al.¹.

If 25dB is considered blindness and the patient has a current defect of 7dB and a progression rate of 2dB/year, the patient’s eye will go blind within 9 years.

**Probability**
The probability is applying population based statistics. This novel method has a better ROC (Receiver Operating Characteristic) to identify truly progressing eyes than standard statistics². A small number means that the same behaviour would hardly (at this icon with 1% probability) occur by accident.

Glaucoma has a diffuse and a local component. For this reason and for the possibility of a developing cataract, EyeSuite calculates not only the trend of the traditional indices MD and sLV (PSD) but also of an index DD for Diffuse Defect and LD for Local Defect. LD was originally introduced as Abnormal Response Area, ARA, at ARVO 2006.

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New Global Indices DD and LD

EyeSuite introduces 2 new global indices in addition to MD and sLV: DD for Diffuse Defect and LD for Local Defect. They are based on the Bebie curve.

The Bebie curve lines up all local defect values (deviations) from the best to the worst.

The general height of the curve indicates the diffuse loss. A drop of the curve on the right side indicates local loss.

A range of 5 to 95% of normality is displayed (light blue) to judge if the patients responses are within a normal bandwidth. The average behaviour of a normal subject would correspond to the 50th percentile, the black line in the center of the light blue area.

On the left side, a “false positive peak“ may arise due to „trigger happy“ behaviour. To exclude this flaw from the calculation, the general height of the visual field is calculated around ¼ of the x-axis.3

**Diffuse Defect DD**

The difference between the average normal general height and the visual field's individual height is the Diffuse defect (dark blue band), expressed in dB.

**Local Defect LD**

LD is the area between the patient's defect curve and the 50th percentile of the defect curve when shifted by DD. It is an index that highly correlates with sLV but is less susceptible to false positives. Beyond the usage in white/white perimetry it is especially helpful as early identifier for abnormal results in perimetry methods with higher inter subject variability such as blue/yellow (SWAP) or flicker perimetry. LD is expressed in dB and normalized to be comparable between different program patterns. LD has been introduced at ARVO 2006 4 as „ARA“, Abnormal response area.

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3 Zulauf M, Becht C, Bernoulli D, False positive peak of the Bebie curve as a reliability parameter, Perimetry Updates, Amsterdam: Kugler Publications, 1996–97;185–90.

Display of Global Trend in EyeSuite

The trends for all 4 global indices together with the series overview of the visual fields are displayed for both eyes, giving a complete picture.

Both eyes Comparison (Deviation) maps are displayed in a series overview on the bottom. By default, EyeSuite shows all of them in the trend graphs and selects the most recent 6 ones to calculate the progression rate and significance. Thus an immediate judgment of changing components in both eyes catch the eye thanks to the icons identifying significant changes.

Using the Windows convention, the selection of visual fields for inclusion / exclusion in the trend calculation can be changed. (Ctrl + Click will alter the selection of any visual field.) In addition, a right click in the OS or OD line always allows to go back to either the default selection or to select all visual fields.

X of Y False Positives
X of Y False Negatives
Only in HFA examinations, there may be an „XX“ for excessive rate of fixation losses (>33%)
Polar Graph

The polar graph shows a red line with its length corresponding with the defect of each test location at the nerve fiber angle at the optic disc. The orientation is vertically mirrored compared to the representation in the visual field to match morphologic representation as HRT or Fundus images.

Legend to the Polar Graph:
Orientation: S / N / I / T: Superior, Nasal, Inferior, Temporal (corresponding with fundus images and digital imaging results)
Grey area: Normal range (local defect of -4dB to +4dB)
Blue rings: 10/20/30dB local defect. Local defects around 30dB are absolute defects.

Polar Trend is a point wise linear regression using the Polar Graph

Red and green lines: Point wise linear regression analysis (PLRA) for each test location at the corresponding nerve fiber angle at the optic disc.

**Red line length:** Worsening (the outer end corresponds with the actual defect).
The length of the line is the worsening in dB as calculated by the PLRA

**Green line length:** Recovery (the inner end corresponds with the actual defect)
The length of the line is the recovery in dB as calculated by the PLRA

The PolarGraph helps correlate functional with structural findings – eg with the TCA of the HRT software. This is facilitated by using the same orientation and color coding. Even subtle changes that do not appear significant can be identified and judged.
Cluster Graph
The test locations of the visual field are grouped into 10 clusters according to their nerve fiber bundles. The clusters allow to identify regional, superior/inferior and intereye differences. Even more, the clusters can be analyzed as absolute defects and as shift corrected defects – corresponding to the pattern deviation.

**Single field analysis**
The cluster graph is a combined display to show probability and amount of a deviation from normal.

- „+“ signs reflect normality (p > 5%)
- Numbers in a normal font indicate the 5% probability and show the average cluster defect in dB
- Numbers in a **bold** font indicate the 1% probability and show the average cluster defect in dB

**Trend analysis**
ClusterTrend identifies the regions of change, cluster change rates and significance of trend. Areas of interest are marked with icons.

- Numbers: Progression rate dB/year
- ▼ worsening at 1% probability
- ▼ worsening at 5% probability
- ▲ recovery at 1% probability
- ▲ recovery at 5% probability
- ◆ fluctuation at 1% probability
- ◆ fluctuation at 5% probability

Combined icons indicating a combination of significant trend and significant fluctuation, for example ▼▲ can be displayed in an extended mode.

The “probability” indicates the number of cases that reach this level of deviation. Hence a probability of 1% means that only 1% of normal cases would show such a behaviour.

Initial changes usually are recognized because the fluctuation increases. As soon as the trend becomes significant, the icon changes to show the direction of trend (worsening or recovery).
Absolute and Corrected Cluster Trend
For each cluster, the change rate is calculated, based on its average deviation from normal. Non-glaucomatous effects such as the learning effect or a developing cataract influence the general height of the defect depth. To compensate for this error, it is possible to switch between the „Cluster trend“ (absolute defects) and „Corrected cluster trend“ (Defects corrected by the diffuse defect DD, corresponds to the pattern deviation).

By default, the cluster trend is displayed if the general sensitivity is decreasing, as this is the case in advanced glaucoma as well as in some early stages of glaucoma. The Corrected cluster trend is displayed if DD is improving, to compensate for the learning effect. If there is evidence of a diffuse worsening due to cataract, the user can click on the icon in the upper left corner to switch between the display modes.

Source
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