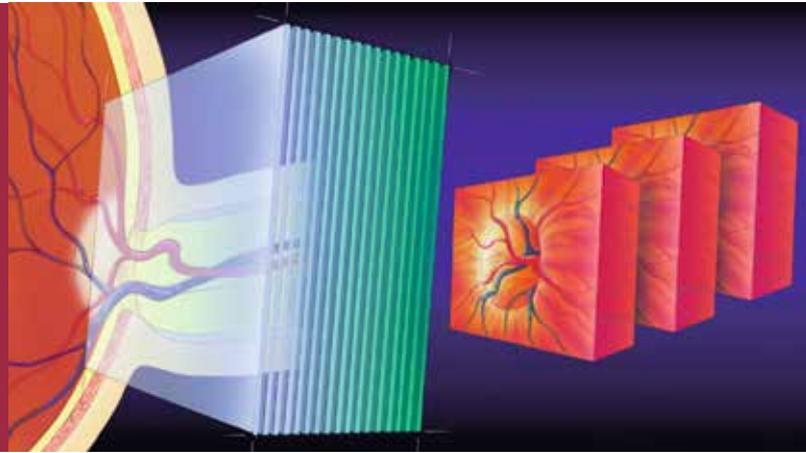


## Measure of Confidence



Glaucoma Module – Premium Edition

# The Changing Face of Glaucoma Practice



## Literature

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- 2 Doughty et al., *Surv Ophthalmol* 2000; 44:367-408
- 3 Liu et al., *Invest Ophthalmol Vis Sci* 2003; 44:1586-1590
- 4 Quigley et al., *Invest Ophthalmol Vis Sci* 1989; 107:453-464
- 5 *Glaucoma Diagnosis – Structure and Function, Consensus Series AIGS* 2004, Kugler Publications, The Hague, The Netherlands
- 6 Keltner et al., *Arch Ophthalmol* 2000; 118:1187-1194
- 7 Abrams et al., *Ophthalmology* 1994; 101:1662-1667
- 8 Zangwill et al., *Am J Ophthalmol* 1995; 199:415-420
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- 10 Zangwill et al., *Am J Ophthalmol* 2004; 137:219-227
- 11 Zangwill et al., *Arch Ophthalmol* 2005; 123:1188-1197
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- 13 Kass et al., *Arch Ophthalmol* 2002; 120:701-703
- 14 Kamal et al., *Br J Ophthalmol* 2000; 84:993-998
- 15 Garway-Heath et al., *Br J Ophthalmol* 1997; 81:840-845
- 16 Bowd et al., *IOVS* 2004; 45:2255
- 17 Wollstein et al., *Ophthalmology* 2000; 107:2267-2271

## Functional and Structural Diagnosis

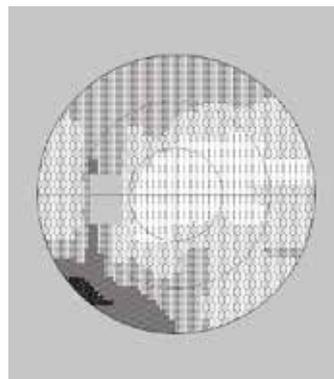
Glaucoma diagnosis in clinical practice has been traditionally based on IOP, visual fields and subjective assessment of the optic disc, but these methods have many limitations.

### IOP

- Large overlap between healthy and glaucomatous eyes<sup>1</sup>
- Corneal thickness affects accuracy<sup>2</sup>
- IOP fluctuates<sup>3</sup>
- Many glaucoma patients have normal IOP

### Visual Fields

- Poor sensitivity for early detection<sup>4</sup>
- Highly variable<sup>5</sup>
- In fact, the OHTS reports that 86 % of visual field abnormalities were not replicated on retesting<sup>6</sup>
- Subjective



## Subjective Assessment of the Optic Disc

- Poor agreement on interpretation, even among experts<sup>7,8</sup>
- Progression missed in up to 50 % of the time by experts<sup>9</sup>
- Time consuming
- Subjective

Therefore, an objective structural assessment of the optic disc is necessary.

The HRT is proven to be as good or better than expert readers of optic disc photographs<sup>10,11</sup> and provides fast, objective assessment of the complete optic nerve head structure including the retinal nerve fiber layer. In addition, the HRT provides an objective validated statistical analysis to show glaucomatous progression.<sup>12</sup>



*“A compelling reason to image the optic disc and nerve fiber layer in glaucoma is that structural changes often precede visual field loss – sometimes by several years.”*  
*Robert N. Weinreb M.D., March 2001*

**Early Detection: Optic Disc Changes First**

The Ocular Hypertension Treatment Study (OHTS), a longitudinal, multicenter study supported by the National Eye Institute (NEI), analyzed glaucoma diagnosis and treatment of ocular hypertensive patients.

The study<sup>13</sup> showed that for 55 % of glaucoma patients optic disc changes could be measured first, whereas for 35 % visual field changes could be detected first.

These results demonstrate that analysis of the optic nerve head structure is a pivotal aspect of glaucoma diagnosis, as a large proportion of glaucoma patients can be missed if it is not part of the examination.

The HRT enables quantitative evaluation of all relevant anatomical structures – cup, rim and RNFL (retinal nerve fiber layer). With the highest spatial resolution of any imaging device for glaucoma diagnosis, the HRT provides comprehensive data for glaucoma detection and follow-up assessment.

**Complete ONH Assessment**

The HRT checks all vital structures of the optic nerve head:

**CUP**

- C/D Ratio
- Shape
- Asymmetry

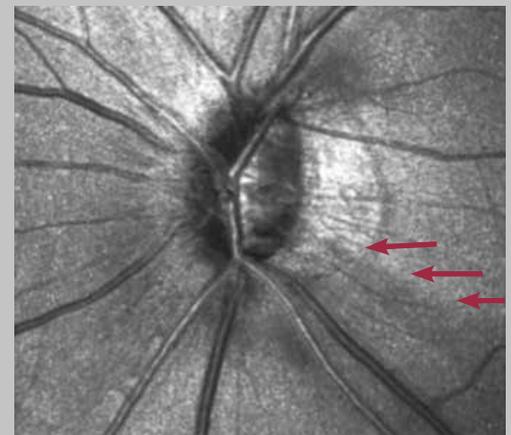
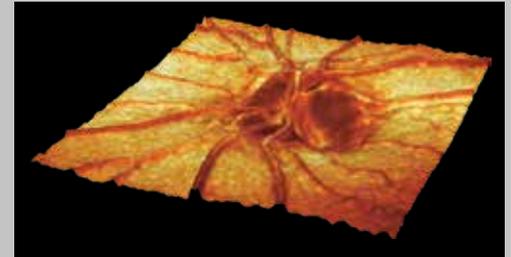
**RIM**

- Area & Volume
- Asymmetry

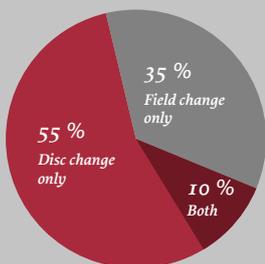
**RNFL**

- Height Variation Contour
- Thickness
- Asymmetry

These stereometric parameters are compared to comprehensive, ethnic-specific databases.

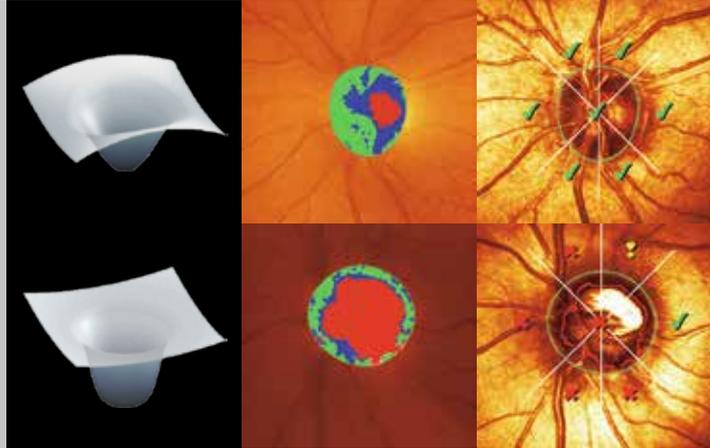


*How Glaucoma is Detected<sup>4</sup>*



# Baseline Examination – Assessing Risk

## *Classification with the Glaucoma Module – Premium Edition*



### Extensive normative database

- More than 1,000 eyes
- Ethnic-specific
- Large range of disc sizes
- Basis for classification of eyes using MRA and GPS and for normative ranges of all structural measurements (stereometric parameters)

Glaucoma risk classification is performed by a comparison of the examined eye to large sets of eyes.

The Premium Edition software offers two classification methods using different approaches.

#### **Moorfields Regression Analysis (MRA)**

This method is based on knowledge of physiological relationships as the dependence of neuroretinal rim area on optic disc size, the possibility that neuroretinal rim area may decline with age, and knowledge of the glaucomatous process. The MRA classifies an eye into a high risk or low risk group on the basis of a 2-dimensional analysis of the rim/disc area ratio adjusted for disc size and age of the patient. Results for each optic nerve head are displayed for six sectors and globally.

#### **Glaucoma Probability Score (GPS)**

The shape of the optic nerve head changes as a normal eye converts to glaucoma. Using advanced artificial intelligence, the software employs a new 3-D shape analysis, combining measures of the optic nerve head and peripapillary retina into one sophisticated model.

The following structures are taken into account:

#### **Disc Components**

- Cup size
- Cup depth
- Rim steepness

#### **RNFL Components**

- Horizontal peripapillary RNFL curvature
- Vertical peripapillary RNFL curvature

This model, combining all vital structures, is compared to a large database of normal and early glaucoma eyes.

The GPS classification method does not require operator intervention and is completely user-independent.



### Evidence Based Medicine: Predicting Glaucoma

The latest OHTS Ancillary Study<sup>11</sup> proves that the HRT can detect early stages of glaucoma, before the visual field becomes abnormal or the clinical assessment of the optic disc reveals abnormalities.

In the study, patients with high IOP but normal visual fields and normal optic disc structure – according to expert assessment of stereo-disc photographs – were examined. It was demonstrated that a positive HRT result has the highest predictive value for the future development of glaucoma.

The study results, recently published by Zangwill et al. from the University of California, San Diego, show that most HRT measurements could significantly predict from the baseline examination, which ocular hypertensive patients would convert to glaucoma in the coming years and which would not.

Signs of structural glaucomatous changes of the disc were detected up to 8 years before either the visual field became abnormal or the optic disc had detectable damage according to expert assessment of stereo-disc photographs. Classification with the Moorfields Regression Analysis (MRA) was significantly associated with the development of POAG.

A positive HRT result represents a 5 times higher risk of developing POAG. For comparison: a CCT value 40  $\mu\text{m}$  thinner as the study average of 580  $\mu\text{m}$  represented only a 2-fold higher risk; an elevated IOP of 5 mmHg over the study average of 25 mmHg represented only a 1.5-fold risk.

- Approximately 40 % of individuals with an abnormal HRT baseline result (MRA classification in the temporal superior sector) developed glaucoma within 8 years.
- Approximately 93 % of individuals with a normal HRT baseline result did not develop glaucoma over the follow-up period.

In clinical practice, the identification of low-risk patients is of special importance given that most ocular hypertensives do not develop glaucoma.

### OHTS Ancillary Study<sup>11</sup> in a nutshell

The OHTS is the only prospective, randomized, multi-center longitudinal clinical trial that assessed the predictive value of any imaging device.

<i>Purpose:</i>	<i>Predictive value of the HRT for primary open angle glaucoma (POAG)</i>
<i>Participants:</i>	<i>438 patients, 865 eyes</i>
<i>Study criteria:</i>	<ul style="list-style-type: none"> <li>■ <i>IOP <math>\geq 21/24</math> and <math>\leq 32</math> mmHg</i></li> <li>■ <i>2 negative visual fields</i></li> <li>■ <i>Normal optic disc according to clinical assessment of stereo-photographs by glaucoma experts</i></li> </ul>
<i>Duration of study:</i>	<i>8 years</i>
<i>Imaging device:</i>	<i>HRT</i>
<i>Results:</i>	<ul style="list-style-type: none"> <li>■ <i>Approx. 8% of eyes developed POAG</i></li> <li>■ <i>Approx. 40% of eyes with positive HRT result (MRA, temp.-sup.) developed POAG</i></li> <li>■ <i>A positive HRT result represents a 5 times higher risk of developing POAG</i></li> </ul>
<i>Summary:</i>	<i>A positive HRT result is one of the highest risk factors for POAG.</i>

# Analysis of Relevant Changes

*Progressive structural ONH damage as the new “Gold Standard”*



## The new “Gold Standard” in Glaucoma Diagnostics

For “at risk” patients, progressive damage of the nerve fiber tissue will lead to the diagnosis of glaucoma. If the disease is progressing, the rate of progression will guide clinical management.

The Association of International Glaucoma Societies (AIGS), the leading group of glaucoma specialists from all over the world, has proposed “Progressive Structural Optic Nerve Damage” as the new “Gold Standard” for glaucoma management.<sup>5</sup>

## Follow-up Examinations with the Glaucoma Module

In line with the new definition of glaucoma, the HRT accurately measures true, reproducible structural changes. It offers the analysis of all vital structures – cup, rim and RNFL – over time.

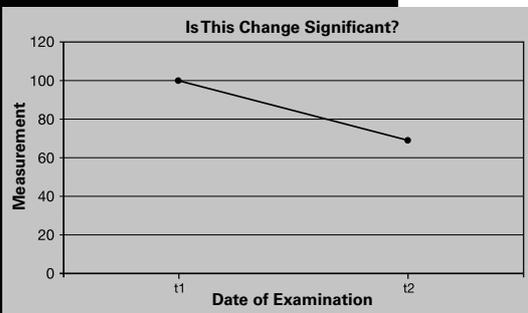
The analysis of topographic changes with the HRT is an objective method to assess different variants of structural change of the optic nerve head and of the peripapillary nerve fiber layer.

Only with mature statistical methods can true structural changes be distinguished from random variability. The HRT offers these

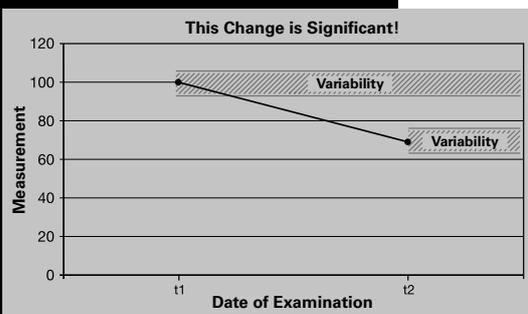
methods. The Topographic Change Analysis (TCA) displays significant, reproducible changes and is the only technology objectively tracking the complete optic nerve head structure over time by

- comparing the complete acquired data over time;
- automatically applying statistical analysis of data and displaying only significant, reproducible changes.

In long-term studies, analyses of follow-up examinations with HRT have been shown to considerably support the diagnosis and treatment of glaucoma patients.<sup>12, 14, 15, 16, 17</sup>



*Without knowledge of measurement variability, only the absolute change can be measured.*



*An accurate value of the measurement variability enables to distinguish real change from natural measurement variability.*



### Online and Offline Quality Control

The Glaucoma Module software offers active support in image acquisition and assessment of image quality. During image acquisition, the online quality control supports in achieving an optimum image quality. Further details are available after the acquisition, helping the operator to assess image quality and improve his acquisition technique.

### Networks, Patient Data Management

Patient reports can be viewed on the screen, saved as jpg or bmp file and e-mailed to a colleague or reading center for second opinion. For simultaneous use of the software on several computers within a network, additional networking licenses can be obtained. The Heidelberg Eye Explorer operation system can be connected to patient data management software systems, enabling quick and convenient import of patient data into the electronic medical record.

### Viewer Software

Optional viewer software is available, enabling full access to all images and patient data on additional PCs. Participants of telemedicine projects who do not have an HRT in their practice can use the viewing software to import, analyze and archive data.

### Other Modules

The Glaucoma Module can be used independently or in conjunction with other software modules. The Retina Module locates and quantifies retinal edema, whereas the Rostock Cornea Module provides in-vivo imaging of cornea, limbus and conjunctiva. Patient data from all different modules as well as other Heidelberg Engineering products based on HEYEX are accessible in one patient database.

## Advantages in daily practice

- Patient friendly examination without pupil dilation
- Predicts glaucoma years before fields or photos
- Accepted technology – more than 8,000 users worldwide
- Acquisition within seconds
- Networked patient records
- E-mail results
- Evidence based medicine – over 500 studies have proven the accuracy and reliability of the HRT
- Information material on data interpretation and patient information material supports in the optimum use

*Heidelberg Retina Tomograph – innovations for glaucoma diagnostics.*





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