Optic nerve head measurements: The optic nerve head analyzer – its advantages and its limitations

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Summary

The Optic Nerve Head Analyzer (ONHA) calculates by means of computer-assisted analysis of stereo images different parameters of the optic disc: disc diameter, disc size, cup/disc ratio (CDR), neuroretinal rim area, and excavation volume for the disc quadrants and for the total disc. To obtain first indications of the clinical value of ONHA measurements for diagnosis and follow-up in glaucoma we examined the reproducibility of measurement results for different diseases. Furthermore, we studied the mean values of the different disc parameters in healthy eyes. It was investigated: 1) whether the reproducibility is different in the different disc parameters; 2) whether the reproducibility in different eye diseases is different as compared to healthy eyes; 3) by which criteria the reproducibility is influenced; 4) whether there is a correlation between disc size and size of rim area.

The reproducibility was studied in 178 eyes of 178 patients, who were all examined twice with the ONHA. The mean difference between the results of first and second measurement was calculated for the different disc parameters. Differences were found in the reproducibility of the parameters: e.g., the mean difference between first and second measurement was 1.8 percent for the disc size, and 5.6 percent for the neuroretinal rim area. For the disc quadrants, the reproducibility of values was worse than for the total disc. No marked differences of reproducibility of disc parameters were found for different diseases. Reproducibility depends, for instance, upon correct determination of the disc margin. In healthy eyes, a significant correlation was found between rim area and disc size: larger discs have a larger neuroretinal rim area than smaller discs. Thus, the rim areas of different eyes are only comparable for equally sized discs. Relative values, as for instance, cup/disc ratio, or the quotient of rim area and disc size, are therefore better suited for comparison of different eyes than absolute values.

The recent developments in automatic disc analysis equipment and the clinical relevance of the results for diagnosis and follow-up in glaucoma are discussed.

Introduction

Changes of the optic disc can be measured by means of computerized image analysis. The following instruments for the automated biomorphometry of the papilla have been developed: the Optic Nerve Head Analyzer of Rodenstock (ONHA); the Imagnet Topcon of Topcon (before: PAR-Analyzer); for both first clinical experiences were published [1, 3, 4, 5, 7, 9, 10, 13, 16-21]. Besides,
there are the Laser Tomographic Scanner of Heidelberg Instruments, the Humphrey Fundus Analyzer, and the confocal Laser Scan Ophthalmoscope of Zeiss. The measurements with these instruments are independent of observer variance to a large degree. However, the clinical relevance of these measurements is largely unknown as yet.

In Würzburg, we have been working for one year with the Optic Nerve Head Analyzer (ONHA) using the latest software version from February 1987.

In order to verify the relevance of these new measuring methods for diagnosis as well as follow-up purposes, two main points must be investigated:

A. Which are the measurement values for the different disc parameters in healthy eyes, and what is the interindividual scattering range of normal measurement values?

B. Is the instrument suited for registration of disc changes? To answer this, the reproducibility of disc measurements in the follow-up must be studied, both for healthy eyes and for eyes with different diseases.

The present study examined both questions for the ONHA.

Examination methods

Aims of examination

A. Disc parameters in healthy eyes:

1. To obtain first indications of the clinical value of ONHA measurements for diagnosis and follow-up in glaucoma, we examined the mean values of the different disc parameters of the total papilla in healthy eyes.

2. The mean values for the cup/disc ratio (CDR) in healthy eyes in all disc quadrants were obtained and studied with respect to significant differences.

3. The extent of the correlation between neuroretinal rim area and size of the papilla was examined. In glaucoma diagnosis, it seems important whether the neuroretinal rim area is a parameter which depends upon the total size of the disc. If this is the case, we can conclude on the amount of remaining neurogenic substance only by taking into account the corresponding size of the optic disc.

4. We studied the question to what extent the frequency distribution of measurement values for the neuroretinal rim area allows a clear separation of normal eyes and eyes with low tension glaucoma.

B. Reproducibility of disc parameters:

Reproducibility of measurements is one of the preconditions for registration of disc changes. Our study is based on double examinations under the following aspects:

1. Are there differences in the reproducibility of the different disc parameters?

2. Are there specific differences in reproducibility of parameters in healthy eyes, glaucomatous eyes, in ocular hypertension, and in diabetic retinopathy? Is, therefore, the usefulness of the ONHA with regard to reproducibility different for the different eye diseases?

3. Is the reproducibility of measurements of the total disc different from measurement reproducibility for the disc quadrants? Is it possible, then, to evaluate disc changes in the single quadrants?

4. Which factors influence measurement reproducibility?

Description of instrument. The ONHA [4] essentially consists of a video camera supplying simultaneous stereo-photographs of the fundus. The three-dimensional structure of the optic disc is achieved by projecting a pattern of stripes onto the disc and by photographing from two different angles (Fig. 1, left).

Thus, for instance, a disc excavation causes a deformation of the projected stripes, which results in an antipodal shifting of the stripe pattern. This deformation of the pattern provides the information on depth necessary for the computerized image analysis. The depth information of the disc excavation is shown on the screen either as profile sections, or as a topographic map. This topographic map has differently coloured areas. The transition from one colour to the neighbouring next col-