Notes on Diagnosing Preperimetric Glaucoma with the Confocal Scanning Laser Ophthalmoscopy

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Original Scientific Paper
UDK 617.7-007-07:681.7.069.24
Received: 27 May 2009

In the past few years many new diagnostic methods for diagnosing and monitoring glaucoma have appeared, such as Heidelberg Retina Tomograph (HRT), Optical Coherence Tomography (OCT) and Scanning Laser Polarimetry (GDx). With this review we wanted to evaluate the use of Heidelberg Retina Tomograph (HRT2) in early glaucoma detection and we wanted to show that in some patients with diagnosed preperimetric glaucoma we can detect structural changes of the optic nerve head (ONH) with the help of HRT2. We evaluated a group of patients who did not experience any changes in visual field but who had early changes of ONH, which was discovered by a quantity morphological analysis of ONH with the help of confocal laser scanning system. Patients included in the analysis had intraocular pressure (IOP) above 21mmHg as measured with Goldmann applanation tonometer. The appearance of the ONH was clinically abnormal with localized or general damage of optic nerve fibers and cup/disc ratio above 0.7. Visual field assessment was performed by Humphrey Field Analyzer (24-2 full threshold strategy) and showed no visual field defects. Scanning of ONH was performed by HRT2 scanning laser ophthalmoscope. The analysis of appearance of scanned ONH was performed using Moorfields Regression Analysis (MRA). According to MRA of the scanned optic nerve head for the above mentioned patients, ONH was outside normal distribution range. In conclusion, we want to accentuate the importance of considering all of the parameters for diagnosing glaucoma in clinical praxis. With new diagnostic methods such as HRT2 we can get an additional parameter that should be included in the glaucoma diagnostic algorithm.

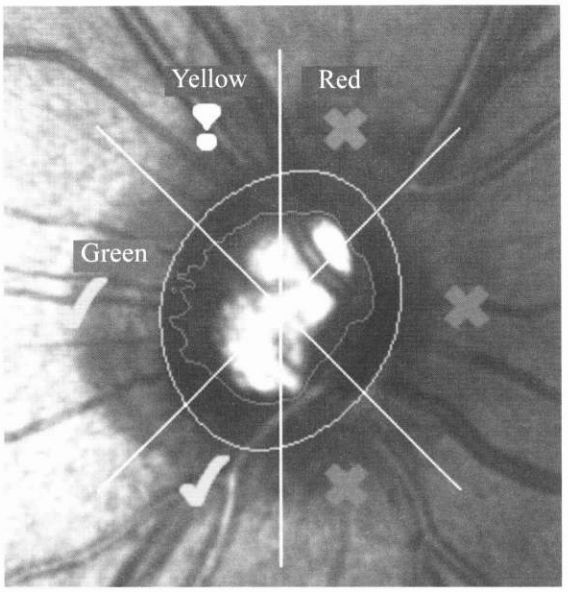
Key words: Glaucoma - diagnosis; Preperimetric glaucoma; Diagnostic techniques, ophthalmological; Microscopy, confocal; Tomography, optical coherence; Early diagnosis

INTRODUCTION

Modern diagnostic methods such as Heidelberg Retina Tomograph (HRT), Optical Coherence Tomography (OCT) and Scanning Laser Polarimetry (GDx) play an important role in diagnosis and management of glaucoma (1-4). In this report we evaluate a group of patients who did not experience any changes in visual fields, but who had early changes of the optic nerve head. Changes were detected by performing quantitative morphologic analysis of the optic nerve scanning results using confocal laser. The aim of this report is to present a group of patients with preperimetric glaucoma, which was diagnosed with the help of confocal laser scanning system (HRT2).

The HRT2 is a confocal scanning laser ophthalmoscope that enables laser scanning of the optic nerve head (ONH). Laser scanning lasts for a couple of seconds and is completely painless, non-contactable, and results are calculated by the computer. The advantage of HRT2 in comparison to simple two-dimensional photography is that it enables a real three-dimensional imaging of the optic nerve head. HRT2 provides for rapid and reproducible topographic measurements of the optic disk. Measurements performed include a size of the optic disc; contour and shape of the optic disc, neuro-retinal rim, and optic cup, along with measurements of peripapillary retina and nerve fiber layer. Using these measurements we can avoid subjectivity and inter- and intra- observer variability that is usually present with simple photography. Patient follow-ups can detect the smallest changes of nerve fiber layer and can very precisely show us progression of the disease (5,6,7).

Moorfields Regression Analysis (MRA) is a computer analysis derived from the empirical knowledge of physiological relationships of the optic disc and dependence of neuro-retinal rim on age, sex, race and progression of glaucoma (8,9). The algorithm is based on the analysis of all segments of the optic disk and is divided into 6 sectors. This approach was first applied to the planimetry measurements of the optic disk head. Pictures of the optic disk were taken, and then were transferred to confocal laser scanning system (10,11). The logarithmic function of the MRA uses the relationships of neuro-retinal rim and optic disc from the computer database and compares the relationships with readings for the scanned optic disk.



Yellow / žuto
Green / zeleno
Red / crveno

FIGURE 1

Moorfields Regression Analysis of the optic disc. Group of average or normal optic disk coincides with 50% of predicted results (marked green), borderline results between 95% and 99% (marked yellow), and results between 99% and 99.9% outside normal limits (marked red)

SLIKA 1.

Moorfields Regression Analysis optičkoga diska. Grupa prosječnih ili normalnih optičkih diskova podudara se s 50% predviđenih rezultata (označeno zeleno), graničnih rezultata između 95% i 99% (označeno žuto) i rezultata između 99% i 99,9% izvan normalnih granica (označeno crveno)

TABLE 1
GENERAL DATA AND RESULTS OBTAINED FROM PATIENTS
TABLICA 1.
OPĆENITI PODACI I REZULTATI DOBIVENI ANALIZOM PACIJENATA

Sex/Spol	Age/Dob	IOP mmHg	Visual Field/ Vidno polje	HRT – MRA – defects in segments abnormal and borderline sectors / oštećenja u području abnormalnih i graničnih područja	
				Right eye/ Desno oko	Left eye/ Lijevo oko
F	64	21 – 26	Normal	3/6	1/6
M	52	21 – 24	Normal	2/6	4/6
M	71	28 – 34	Normal	4/6	3/6
F	48	24 – 30	Normal	2/6	1/6
F	66	18 – 23	Normal	2/6	2/6

HRT - Heidelberg Retina Tomography, MRA - Moorfields Regression Analysis

The computer evaluates the parameters and classifies scanned optic disk into groups. Group of average or normal optic disk coincides with 50% of predicted results (marked green), group with borderline results between 95% and 99% of predicted interval (marked yellow) and finally group of results between 99% and 99.9% outside normal limits (marked red) (Figure 1).

Preperimetric glaucoma is defined as: intraocular pressure (IOP) above 21mmHg, abnormal clinical appearance of ONH, and no changes in the visual field (12).

MATERIALS AND METHODS

Patients included in the analysis had IOP above 21mmHg as measured with Goldmann applanation tonometer. The appearance of the optic disk was clinically abnormal with localized or general damage of the optic nerve fibers and cup/disc ratio above 0.7. Visual field assessment was performed by Humphrey Field Analyzer (24-2 full threshold strategy) and showed no visual field defects. Scanning of ONH was performed by HRT2 scanning laser ophthalmoscope specifically designed to acquire three-dimensional images of the optic nerve head. Results were analyzed using Moorfields Regression Analysis (MRA).

RESULTS

General data obtained from five patients included in this report are described in Table 1. All patients had an open angle of front ocular chamber and until now were not diagnosed with glaucoma. No patient had astigmatism of more than 1 diopter, which is important for the quality of the image acquired by the HRT2. During regular eye check-ups high IOP was measured on at least 3 different occasions and corrected according to pahimetric values (Table1). Visual field assessment performed by Humphrey Field Analyzer (24-2 full threshold strategy) showed no visual field defects. The analysis of the appearance of the optic nerve head was performed using Moorfields Regression Analysis (MRA), which showed that for the above mentioned patients, optic nerve, according to MRA parameters, was outside the normal distribution range.

DISCUSSION

In the last few years many new diagnostic methods have appeared. However, their impact has been very limited in everyday diagnosis and treatment of glaucoma in our region. This is mainly because they are still relatively expensive. In many cases the Heidelberg Retina Tomograph (HRT2), the nerve fiber analyzer like Scanning Laser Polarimetry (GDx), short wavelength perimetry (SWAP), OCT and the frequency doubling test (FDT) can assists in early glaucoma detection (13). Heidelberg Retina Tomograph (HRT2) plays an important role in diagnosing and monitoring of glaucoma patients. The Ancillary Study of the Ocular Hypertension Treatment Study (OHTS) proved an important role of HRT2 in detection and follow-up of preperimetric glaucoma, the analysis showed conversion to glaucoma in 55% of the cases before detectable loss of the visual field (13,14). Another valuable analysis which can perform HRT2 is Topographic Change Analysis (TCA). TCA is a statistical method used to compare the topographic values of the image called superpixels, which contain 4 x 4 (or 16 pixels) at two points in time. TCA is a powerful analysis, which has been demonstrated to detect very small changes in optic disc and peripapillary retinal topography. The greatest utility of the HRT is in the detection of change, which can be used both for the diagnosis of glaucoma and progression of disc damage. The research shows that HRT2 parameters may be used to detect small ONH changes associated with progression of the Retinal nerve fiber layer (RNFL) defect (15). Comparing the follow up of glaucoma progression with GDx and HRT2, results showed better predictability than OCT. Although test-retest variability increased with disease severity for rim area, variability of vertical cup/disc ratio (HRT2) and global RNFL (GDx) was stable across disease severity (16).

It should be noted that it is not always possible to obtain satisfactory image quality because of patient's noncompliance or the opacities of the optical media. In those cases irregularities in measurements may occur, therefore it is necessary to pay attention to the parameters which show the quality of the image and disregard the analysis of those images (17). Image quality is also influenced by astigmatism and age of the patient (18). In advanced glaucoma with visual field defects, many researchers proved overlap in the changes of the optic disk with visual field defects (19,20,21). To maintain the objectivity of the report it must be noted that HRT2 analysis can show normal optic disc head despite obvious visual field defects (22). In our report we wanted to show that in some patients with diagnosed preperimetric glaucoma, we can detect structural changes of the optic nerve head with the help of HRT2.

In conclusion, we want to accentuate the importance of considering all parameters for diagnosing glaucoma in clinical praxis i.e. level of IOP, clinical appearance of the optic nerve head, and visual field assessment. With new diagnostic methods, such as HRT2, we can get an additional parameter that should be included in the earlier described diagnostic algorithm. It is important to interpret the measurements correctly and to be aware of the limitations of HRT2 diagnostics. In combination with careful clinical evaluation, HRT2 can make the diagnosis of the glaucoma earlier and more successful.

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BILJEŠKE O DIJAGNOSTICIRANJU PREPERIMETRIJSKOGA GLAUKOMA S POMOĆU KONFOKALNOGA SKENIRAJUĆEGA LASERSKOGA OFTALMOSKOPA

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SAŽETAK

U posljednje se vrijeme pojavilo mnogo novih dijagnostičkih metoda za dijagnosticiranje i liječenje glaukoma, kao što su Heidelberg retina tomograph (HRT2), Optical coherence tomography (OCT) i scanning laser polarimetry (GDx). Ovim prikazom željeli smo istražiti upotrebu HRT2 uređaja u ranoj dijagnostici glaukoma i pokazati da se kod nekih pacijenata kojima je dijagnosticira preperimetrijski glaukom mogu otkriti strukturalne promijene vidnoga polja uz pomoć HRT2. Obradili smo skupinu pacijenata koji nisu imali promjene u vidnom polju ali kod kojih je kvantitativna morfološka analiza vidnoga živca pomoću HRT2 konfokalnoga laserskog skeniranja otkrila rane strukturne promjene na vidnom živcu. Bolesnici koji su uključeni u skupinu preperimetrijskoga glaukoma imali su povišeni intraokularni tlak iznad 21 mmHg mjeren pomoću Goldmannovoga aplanacijskog tonometra. Izgled vidnoga živca klinički nije bio uredan što je uključivalo lokalizirani ili generalizirani gubitak vlakana vidnoga živca uz povećani c/d odnos iznad 0.7. Vidno polje ispitano je uređajem Humphrey Field Analyzer (24-2 full threshold strategy) koje je pokazalo uredan nalaz. Skeniranje je vidnih živaca provedeno pomoću HRT2 uređaja, a analiza dobivene trodimenzionalne slike vidnih živaca izvedena je pomoću Moorfields Regression Analysis (MRA). MRA je pokazala kako su analizirani vidni živci prema parametrima izvan normalnoga raspona. U zaključku želimo istaknuti važnost razmatranja svih parametara koji su važni za dijagnozu i praćenje glaukomske bolesti u kliničkoj praksi. Pojavom novijih dijagnostičkih uređaja kao što je HRT2 dobiva se još jedan parametar koji svakako treba uključiti u dijagnostičku shemu.

Ključne riječi: Glaukom - dijagnoza; Preperimetrijski glaukom; Tehnike dijagnosticiranja, oftalmološke; Mikroskopija, konfokalna; Tomografija, optička usklađenost; Rana dijagnoza