OPTICAL COHERENCE TOMOGRAPHY IN GLAUCOMA MANAGEMENT

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Keywords: *glaucoma, optical coherence tomography, diagnostic, progression, retinal nerve fibre layer, neuro-retinal rim, cup/ disc ratio*

Abstract: *Glaucoma is a characteristic optic neuropathy which associates high intra-ocular pressure, loss of visual field and structural changes of the optic disc and the peripapillary area. Optical coherence tomography (OCT) is an imagistic method of investigation that is non-invasive and repeatable. It analyses objectively the glaucomatous changes that appear in the retinal nerve fibre layer (RNFL), optic disc (neuro-retinal rim, optic cup, cup/ disc ratio). OCT is a very usefull investiogation for early diagnoses of glaucoma and for predicting the progression rate of the disease (by make succesive measurements).*

Cuvinte cheie: *glaucom, tomografie în coerență optică,diagnostic, progresie, stratul fibreler nervoase retiniene, rim neuro-retinian, raport cup/ disc*

Rezumat: *Glaucomul reprezintă o neuropatie optică caracteristică ce se asociază presiune intraoculară crescută, pierderea câmpului vizual şi modificări structurale ale papilei nervului optic şi a regiunii peripapilare. Tomografia în coerență optică (TCO) este o metodă de investigație imagistică neinvazivă şi reproductibilă care analizează obiectiv modificările glaucomatoase apărute la nivelul stratului de fibre nervoase retiniene, papila nervului optic (rim-ul neuroretinian, escavația papilară, raportul cup/ disc). Este o investigație utilă pentru diagnosticarea precoce a glaucomului şi pentru stabilirea ratei de progresie a bolii (prin efectuarea de măsurători succesive).*

SCIENTIFICAL ARTICLE STIINTIFIC OF THEORETIC PREDOMINANCE

Optical coherence tomography (OCT) is a modern imagistic method that generates cross-sectional images of the ocular structures with an axial resolution close to 10 μm. OCT is similar to B-mode ultrasound, except that it uses light rather than sound. Unlike ultrasound, it does not require contact with the tissue examined.

The technology relies on low coherence interferometry to generate the sectional images. A low coherence infrared light beam of 820 nm wave length is directed toward the target tissue. The reflected light by the microstructures in the target tissue is anlaysed to obtain the images. The image generated is based on the optical properties of the microstructures present in the tissue imaged. The infrared light allows good penetrabillity and to register the reflections from a narrow region of the retina and the anterior segment of the eye. To do this, the light beam generated by ba superluminescent diode is split and simultaneously directed to the imaged tissue and an internal reference mirror. When reflected light form both sources are combined, a phenomenon known as interference occurs. By measuring the interference of the analysed points, the machine displays a realtime tomogram, color coded, depending on the amount of the backscatterd light from microstructures at different depths of the imaged tissue corresponding to different anatomic and histologic structures. The image is color coded, which means that the bright colors (red to white) correspond to high reflectivity and dim colors (blue to black) to minimal or no reflectivity *(1,2).*

Glaucoma is a characteristic optic neuropathy, which is associated or not with high intra-ocular pressure and which leads to progressive loss of the visual field. It's a dizabilitating disease which can have a hidden onset and evolution and which can be diagnosed in advansed stages. Thus it is very important to diagnose it early and to set the progression rateof the disease, in order to decide on the proper treatment (medicamentous or surgical) *(12).*

The disease is characterised by:

- high intra-ocular pressure (> 21 mmHg) – it is not absolutelly necessary because there are forms of glaucoma that have normal intra-ocular pressure or even low intra-ocular pressure.
- structural changes of the optic disc and the peripapillary area.
- loss of the visual field. *(3)*

The optic disc is the place where the retinal nerve fibres leave the eye to form behind it the optic nerve. In the exterior it is surrounded by the scleral ring, next comes the neru-retinal rim (that corresponds to the compacted nerve fibres) and then the disc cup. The optic disc is normally between 1.5 – 2 mm, the width of the rim decreases in the following order: inferior, superior, nazal and temporal (ISNT rule) *(11).*

Glaucomatous optic neuropathy is charcterized by specific structural and functional changes that result from the loss of retinal ganglion cells and their corresponding axons. Clinically these structural changes by thinning of the neuroretinal rimand have traditionally been evaluated by direct clinical observation of the optic disc aided by stereoscopic photographs of the optic disc and the retinal nerve fibre layer.

OCT increases our ability to diagnose glaucoma and to evaluate its progression by generating more objective information about the ocular structures involved in the glaucomatous process. It provides imaging of the optic disc, peripapillary and macular areas, iridocorneal angle, generating reproducible meaurements of the retinal nerve fibre layer, retinal

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Article received on 28.05.2011 and accepted for publication on 24.10.2011
ACTA MEDICA TRANSILVANICA December 2011; 2(4)201-203

thickness and topographic measurements os the optic nerve head.

OCT has the ability to discriminate glaucomatous from healthy eyes more than the visual filed analyses, beacause of the fact that the structural change of the optic nerve head appear before the functinal changes of the visual field *(5,7).*

Retinal nerve fibre layer scans

Sectional images of the peripapillary retina are obtained through a circular scan with a diameter of 3,4 centered on the optic disc. The thickness of the RNFL is automatically calculated by the software by an algorithm that determins its inner and outer limits based on the intensity of reflectivity. The measurements are then compared with the normal ones depending on the age, sex and race that are in machine's database. The average RNFL thickness is calculated for the four quadrants (temporal, superior, nasal and inferior) and represented graphically for an easier understanding and comparison. The data from the two eyes is superimposed on one graph in order to detect the asymmetries between them. (Fig 1, 2)

Figure no. 1 RNFL thickness chart for both shows a decrease in thickness in the superior and inferior quadrants for both eyes

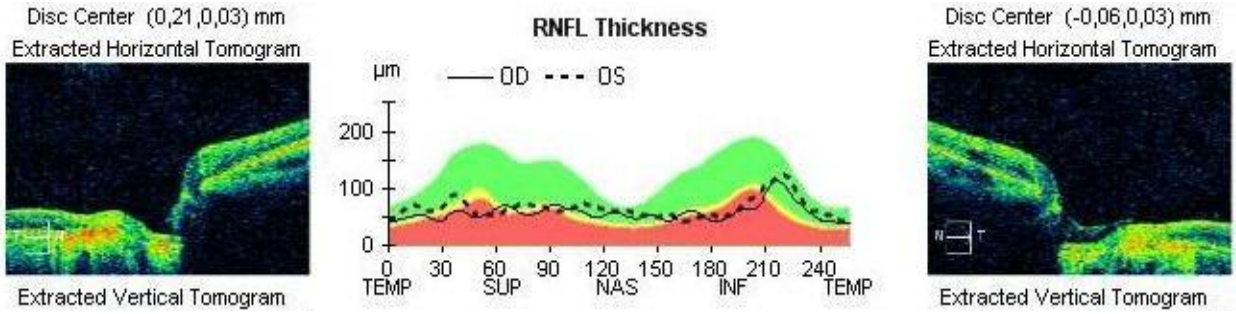


Figure no. 2 Decrease of RNFL thickness in the inferior and superior quadrants for both eyes in the same patient

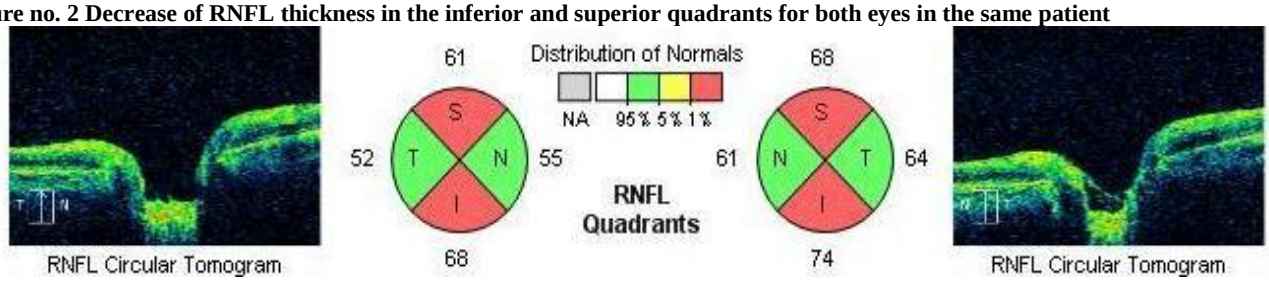
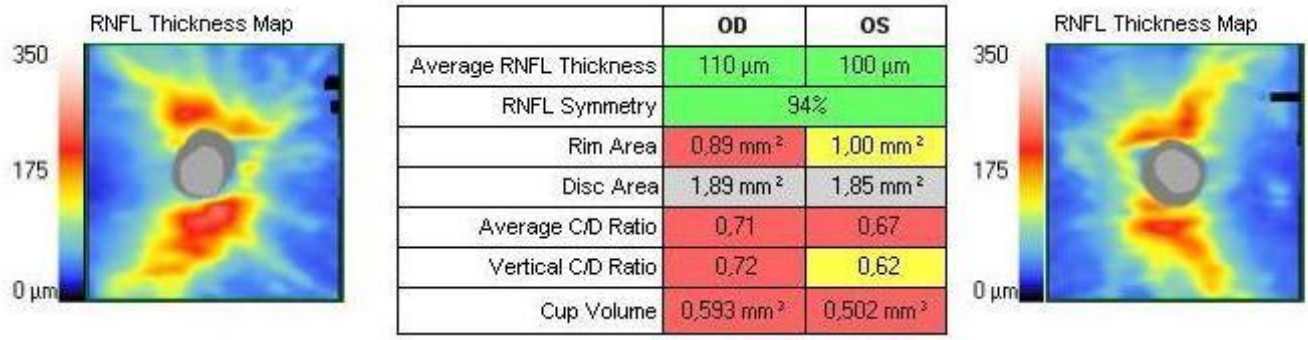
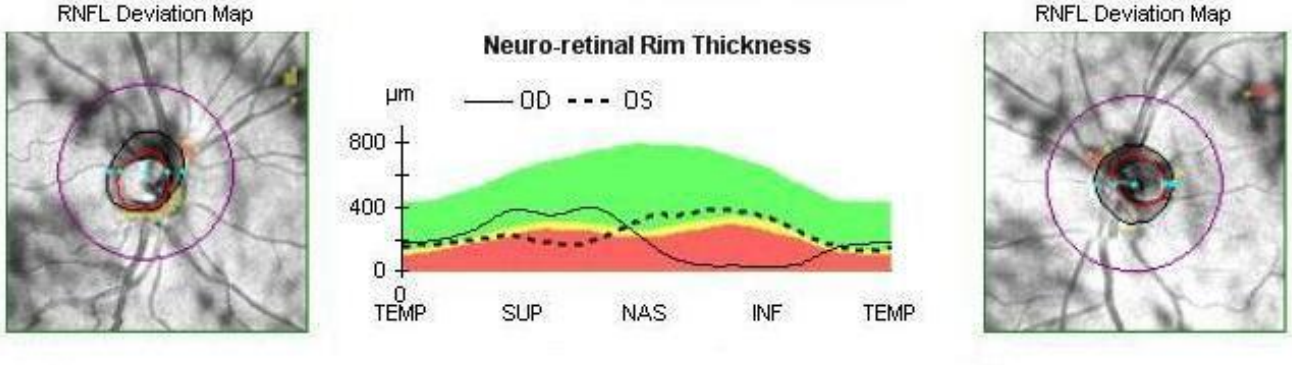


Figure no. 3 Thinning of the neuro-retinal rim, increase of the cup volume and of the cup/ disc ratios



	OD	OS
Average RNFL Thickness	110 µm	100 µm
RNFL Symmetry	94%	
Rim Area	0,89 mm²	1,00 mm²
Disc Area	1,89 mm²	1,85 mm²
Average C/D Ratio	0,71	0,67
Vertical C/D Ratio	0,72	0,62
Cup Volume	0,593 mm³	0,502 mm³

Figure no. 4 Asimmetry of the neuro-retinal rim thickness for the RE and LE and changes in the ISNT rule



Measuring the RNFL with the OCT is very usefull in the early diagnosis of glaucoma because thinning oh the RNFL appears before the visual field changes and the changes in the optic cup *(6).* It is also very important for setting the progression rate of the glaocomatous optic neuropathy. In more advanced cases of glaucoma, the areas of ream thinning corelate with the visual field defects.

Optic nerve head scans

ONH and macular scans are composed of six linear scans in a spoke pattern separated by 30 degree intervals. The disc margins are detected autoamtically by the software by detecting the end of the hiperreflectivity of the choriocapillaris complex – retinal pigment epithelium. The cup is then defined and then the software calculates the disc area, cup area, rim area, vertical and horizontal cup/ disc ratio. The glaucomatous changes detected here are: increase of the cup area, thinning of the neuro-retinal rim (focal or diffuse thinning and changes in the ISNT rule), increase of the cup/ disc ratios *(8).* (Fig. 3, 4)

Macular thickness scans

Macular thickness scans have a complementary role in the diagnoses and management of glaucoma. The loss og ganglion cells in glaucoma has been experimentally demostrated. Ganglion cells are thought to constitute between 30% and 35% of the total retinal thickness in the macular area. Clinically, measuring the changes in macular thinckness may prove to be of value in the management of glaucoma *(4).*

CONCLUSIONS

- OCT is a non-invasive, reproducible, and easy to do imagistic method of investigation.
- it offers objectice measurements of the RNFL, neuro-retinal rim, optic cup, cup/ disc ratios
- it allows an early diagnoses of glaucoma, before the appearance of the functional changes
- it allows the prediction of the progression rate by making succesive measurements.
- it improves the quality of life of the patients, by conserving their visual function.

„Researches realized during the project POSDRU/CPP107/DMI1.5/S/6851 cofinanced from the Social European Fond through the Operational Sectorial Development Programme of the Human Resources 2007 – 2013"

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