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Measurement of Retinal Nerve Fiber Layer (RNFL) Thickness in Glaucomatous and Healthy Subjects

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Abstract: ***The aim of the study was to asses retinal nerve fiber layer (RNFL) thickness in glaucomatous eyes using spectral domain optical coherence tomography and to study their correlations with glaucomatous damage. The study group comprised 105 eyes with primary open angle glaucoma (POAG), glaucoma suspects (GS) and healthy subjects (n = 35 cases in each group). All participants had comprehensive clinical assessment, visual field (VF) testing and OCT scanning. Significantly lower values of the mean pRNFL thickness were found in the POAG (62.10±14.45µm) and GS (100.0±7.15µm) groups as compared with healthy group (107.6 ± 6.10 µm) p<0.01. Also, in pairwise group comparison RNFL in glaucomatous eyes was significantly thinner in all quadrants p<0.05. The mean deviation (MD) was significantly correlated with pRNFL thickness in POAG group (r^2=0.27 p<0.01). In our study-group population the RNFL thickness measured with SD-OCT was significantly thinner in glaucomatous eyes compared to age-matched GS and normal eyes.***

Keywords: Glaucoma, Retinal nerve fiber layer thickness

1. Introduction

Glaucoma is the leading cause of irreversible blindness in the world. Primary Open Angle Glaucoma (POAG) is the most common type of glaucoma. POAG can be considered chronic, progressive optic neuropathy that is accompanied by a characteristic cupping and atrophy of the optic disc, Visual Field (VF) loss, open angles, and no obvious ocular or systemic reason (1). Glaucomatous optic neuropathy causes progressive death of retinal ganglion cells and their axons. These structural changes precede VF defects as measured by standard automated perimetry. The peripapillary Retinal Nerve Fiber Layer (RNFL) thickness evaluation is a useful method to detect the early structural damage of glaucoma (2) Recently, spectral domain OCT (SD-OCT) technology has been introduced providing faster scanning (up to 100) and finer axial resolution (up to 2) compared with TD-OCT.7 Faster scanning allows high-resolution, three-dimensional (3-D) volume sampling by raster scanning in the region of interest. Involving the summation of the back-scattered signal at each transverse point of a retinal raster scan, 3-D SD-OCT data can be visualized as an en face image of the retina. The enface retinal image is also known as an OCT fundus image (3). The OCT fundus image permits the detection of eye movements during scanning by checking for discontinuities in retinal blood vessels. It can also be used to create a virtual OCT cross-sectional image along any sampling line Therefore, near perfect registration of a virtually sampled B-scan image can be achieved (4). The aim of the study was to asses retinal nerve fiber layer (RNFL) thickness in glaucomatous eyes using spectral domain optical coherence tomography and to study their correlations with glaucomatous damage.

2. Material and Methods

Our study included patient from the "Ungjillezimi" clinic in Tirana dsitrict. The study group comprised 105 eyes with primary open angle glaucoma (POAG), glaucoma suspects (GS) and healthy subjects (n = 35 cases in each group). All participants had comprehensive clinical assessment, visual field (VF) testing and OCT scanning. Assessment of peripapillary RNFL thickness was made with circular spectral domain optical coherence tomography (SD-OCT) scans. RNFL measurements in each patient's eye were obtained in temporal, superior, nasal, and inferior quadrants. Analysis of variance (ANOVA) was used for comparison of RNFL parameters among various study groups. The relationship of RNFL parameters with visual field (VF) global indices was evaluated with regression analysis and the coefficient of determination (r^2) was calculated.

3. Results and Discussion

The mean age + standard deviation (SD) of normal subjects was 57.6 + 9.3 years and mean age + SD of glaucoma subjects was 56.4 + 6.1 years. There was no significant difference in age between two groups. No significant difference was found in mean age between the groups p=0.6. Significantly lower values of the mean pRNFL thickness were found in the POAG (62.10±14.45µm) and GS (100.0±7.15µm) groups as compared with healthy group (107.6 ± 6.10 µm) p<0.01. Also, in pairwise group comparison RNFL in glaucomatous eyes was significantly thinner in all quadrants p<0.05. The mean deviation (MD) was significantly correlated with pRNFL thickness in POAG group (r^2=0.27 p<0.01).

RNFL change can be an important indicator for glaucoma progression detection. Among several devices which can measure RNFL thickness, OCT has become one of the most commonly used modalities, and SD-OCT is the latest

version of currently available OCT (5). SD-OCT has afaster scan speed and higher resolution than conventional TD-OCT, which may provide more accurate data registration and subsequent improved measurement reliability (6). Spectral-domain OCT provides many potential advantages for glaucoma diagnosis and follow-up. The axial resolution of commercially available units is currently close to 5µm, and research systems are approaching 2–3µm, which could lead to the detection of subtle changes in the RNFL and the optic disc and result in a better ability to detect disease progression (7). Moreover, the higher scan acquisition speed reduces artefacts and might help to obtain more accurate measurements, which also contributes to reduced measurement variability (8). Higher image resolution will allow for improved segmentation of the retinal layers, leading to more accurate measurements. Focal loss of tissue, which occurs more often in the earlier stages of glaucoma, may be easier to identify. Thus, spectral-domain OCT can potentially acquire a greater sensitivity for early glaucoma diagnosis. 3D images offer the possibility of moving the scan circle on the surface of the scanned cube without the necessity of performing a new examination (9). The wealth of information contained in a 3D data cube allows for evaluation of the RNFL and ONH morphology all in the same scan. Moreover, optic disc parameters are more precise because much less interpolation between adjacent points is necessary than in time-domain OCT (10).

4. Conclusion

In our study-group population the RNFL thickness measured with SD-OCT was significantly thinner in glaucomatous eyes compared to age-matched GS and normal eyes. Values of RNFL thickness can be used as strong diagnostic and predictive criteria in diagnosis of glaucoma. A high resolution SD-OCT can reveal changes in RNFL thickness before visual field defects appear and could aid significantly in the early diagnosis of glaucoma.

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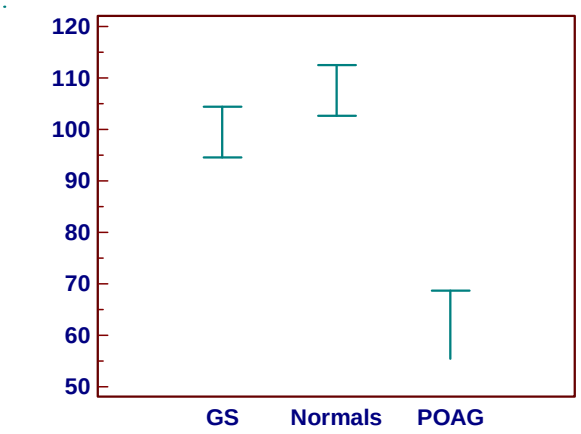

Figure 1: Mean retinal nerve fiber layer thickness (micrometers) for 3 study groups (95%CI error bars)

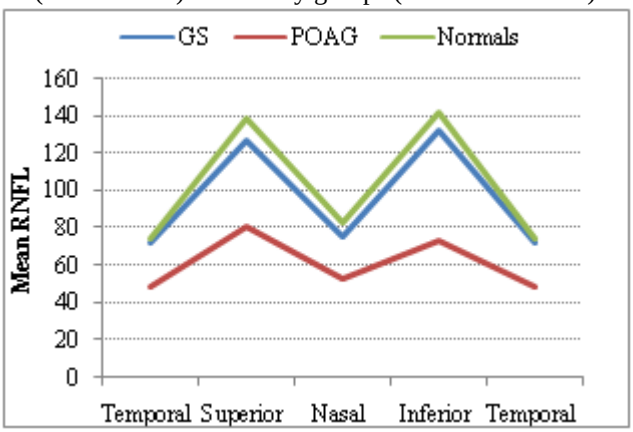

Figure 2: Retinal nerve fiber layer thickness (micrometers) in each quadrant for 3 study groups.