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Macular thickness and retinal nerve fiber thickness analysis ın ocular dominance

Espessura macular e fibra nervosa da retina análise de espessura no domínio ocular

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ABSTRACT

Objective: *To compare macular and peripapillary retinal nerve fiber layer thicknesses of dominant eye and non-dominant eye using optical coherence tomography (OCT).* ***Methods:*** *104 eyes of 52 healthy young adults were included. Ophthalmological examinations; including measuring refraction, best corrected visual acuity, intraocular pressure (IOP) measurement, slit-lamb biomicroscopy, dilated fundus examination, measuring of central macular thickness (CMT), and peripapillary retinal nerve fiber layer (PRNFL) thickness were performed on each subject. Hole-in-the-card test was used to detect the ocular dominance.* ***Results:*** *There were 25 females (48%) and 27 males (52%) in the study. Eight participants had left eye dominance (15%), forty-four participants had right eye dominance (85%). Mean CMT was 192.5μm in dominant group and 191.9 μm in non-dominant group. There was no statistically significant difference between dominant eye group and non-dominant eye group in either macular thickness or peripapillary retinal nerve fiber layer thickness.* ***Conclusions:*** *No difference between macular and peripapillary retinal nerve fiber layer thicknesses were detected in dominant and non-dominant groups. Further evaluation is needed.*

Keywords: *Macula lutea/anatomy & histology; Retina; Nerve fibers; Dominance, ocular*

RESUMO

Objetivo: Comparar as espessuras da camada de fibras nervosas da retina macular e peripapilar do olho dominante e não dominante usando a tomografia de coerência óptica (OCT). **Métodos:** 104 olhos de 52 adultos jovens saudáveis foram incluídos. Exames oftalmológicos; incluindo medidas de refração, melhor acuidade visual corrigida, medição da pressão intraocular (PIO), biomicroscopia de fenda-cordeiro, exame do fundo dilatado, medição da espessura macular central (CMT) e espessura da camada de fibras nervosas da retina peripapilar (PRNFL) foram realizadas em cada sujeito. O teste Hole-in-the-card foi usado para detectar a dominância ocular. **Resultados:** houve 25 mulheres (48%) e 27 homens (52%) no estudo. Oito participantes tinham deixado a dominância do olho (15%), quarenta e quatro participantes tinham dominância do olho direito (85%). A CMT média foi de 192,5 μm no grupo dominante e 191,9 μm no grupo não dominante. Não houve diferença estatisticamente significativa entre o grupo dominante de olho e o grupo de olho não dominante tanto na espessura macular quanto na espessura da camada de fibras nervosas da retina peripapilar. **Conclusões:** Não houve diferença entre as espessuras das camadas de fibras nervosas da retina macular e peripapilar nos grupos dominante e não dominante. Mais avaliações são necessárias.

Descritores: Macula lutea/anatomia & histologia; Retina; Fibras nervosas; Dominância ocular

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Introduction

Some of the organs of the body have functional lateralization, for example hands, legs, cerebral hemispheres and eyes. Brain takes images from two eyes but it uses the images of dominant eye. Porta described the term of ocular dominance in 1593 firstly. In general, ocular dominance is the tendency to prefer visual input from one eye to the other for sighting, sensory and oculomotor tasks.[1,2] The superiority of dominant eye whose visual function predominates the non-dominant eye.

Ocular dominance is in part related to cerebral laterality and hand laterality. There is significantly higher cortical activation in response to the dominant eye than nondominant eye. Most frequently people's dominant eye's side and dominant hand's side are the same, but the opposite is not rare.

Human body is symmetricaly but peripapillary retinal nerve fiber layer (PRNFL) and central macular thickness (CMT) profiles between each eye are not symmetrical and there are a lot of studies about these differences.[3,4] The difference between right and left eyes is still unknown.

Some factors such as neurotrophins, growth factors may affects RNFL thickness and CMT positively or negatively. For example in Parkinson's disease and Alzheimer's disease, PRNFL thinning has been detected. In healthy population it may be associated with ocular dominance.

In this study, we wanted to compare PRNFL thickness and CMT differences between the dominant and non-dominant eye.

Methods

Approval was obtained from the local ethics committee for the study. The study conformed to the tenets of the Declaration of Helsinki.

A hundred-four eyes of fifty-two healthy adults (27 males and 25 females) were included in this prospective comparative study.

Study Population

Healthy adults were aged between 21 and 40 years and were having uncorrected visual acuity 20/20 for both eyes according to the snellen chart examination. Refractive errors of the subjects were between -0,50 and +0,50 diopter.

Exclusion criteria were retinal abnormalities, glaucoma, optic disc abnormalities, diabetes mellitus, dry eye, corneal opacity, anisometropia, amblyopia, strabismus,ocular surgery, bigger than 0,50 D refractive errors and neurological disorders and taking medication that might affect CMT and RNFL thickness.

Comprehensive eye examination were performed for each subjects including measuring refraction and best corrected visual acuity using Snellen chart, intraocular pressure (IOP) measurement, slit-lambbiomicroscopy and dilated fundus examination.

The macular and RNFL thickness of the dominant and non-dominant eye were measured by optical coherence tomography (OCT) (Spectral OCT SLO; Opko/ OTI, Miami, FL) after dilatation of pupil with tropicamide %1 and phenylephrine 2.5%.

Signal strength was rated on a ten-point scale; signal strength values of ≥ six were considered acceptable. Multiple images were taken from each eye by a experienced operator and the scan with the best signal was chosen for the study.

Ocular Dominance

Hole-in-the-card test was used to determine the dominant eye. The patient is given a card which there was a central circular hole 3 cm in diameter. Each patient was asked to hold the card with both hands and to view a target 6 m away through the hole with both eyes open. Each eye was then occluded in turn. When the dominant eye was covered, the target could not be seen through the hole but when the non-dominant eye was covered, the dominant eye continued to fix on the target through the aperture. The test was performed at least three times for each subject and subjects with different results on repeated testing were excluded. Totally 70 subject performed the test but 18 subject were excluded becasue of the different results.

Statistical Analysis

Statistical analysis was performed by using SPSS for Windows 16.0 (SPSS Inc.Chicago, USA). The Kolmogorov-Smirnov test was used to check normal distribution of variables. Normal distribution all of the numerical variables were compared using independent sample T test and the descriptive statistics were expressed as mean±SD. Qualitative variables were compared with chi-square test and descriptive statistics were expressed as percentages (%) and frequency. A P value less than 0.05 was considered statistically significant.

Results

Patient's mean age was 27.92 (standard deviation [SD] 5.5) years. Right dominance was more frequent than left. Eight participants had left eye dominance (15%), forty-four participantshad right eye dominance (85%).

We compared some parameters between dominant and non-dominant eye groups such as horizontal and vertical cup/disc ratio, rim area, disc area, mean cup depth, maximum cup depth, but we did not found any significant statistically difference.

CMT analysis showed us that there was no statistically significant differences between dominant and non-dominant eyes (p:0.892). CMT values are similar in each group. Mean CMT was 192.5µm in dominant eye group (SD 21.4) and 191.9 µm in non-dominant eye group (SD 20.14).

We did not found statistically significant difference when we compare PRNFL thickness in two groups. Average PRNFL thickness was found 110.3 µm in dominant eye group (SD 9.82), 110.6 µm in non-dominant eye group (SD 9.63) (p:0.88). Superior quadrant PRNFL thickness was thinner in dominant eye but there was no statistically significant differences between them (superior quadrant dominat eye 137.86 µm,SD 17.2/nondominant eye 142.96 µm, SD 16.1) (p:0.123). Inferior and temporal quadrant PRNFL thickness analysis of two groups were very similar and also no statistically signaficant differences (inferior quadrant dominat eye 140 µm, SD:15.7, nondominant eye 139.51 µm, SD:16.2) (temporal quadrant dominant eye 74.17 µm, SD:10.9, nondominant eye 74.53 µm SD:12.9) (inferior quadrant p value:0.879, temporal quadrant p value:0.872). When we compared nasal quadrants, we saw non-dominant eye group (87.80 µm, SD:14.9) was thinner than dominant eye group (91.15 µm, SD:17.7) but statistically analysis was not significant different (Table 1).

We also compared right and left eyes. We did not found statistically significant difference in any parameter between left and right eyes except superior quadrant analysis. CMT was thicker in left eyes (193.8 µm) than right eyes (190.6 µm). Superior quadrant PRNFL thickness was found thicker in left eyes than right eyes and this result was statistically significant (p:0.008). İn left eyes,other quadrants (inferior, nasal, temporal) and average PRNFL thickness analysis were founded thinner than right eyes.

Table 1
Inter-ocular comparisons according to ocular laterality and dominance

	Dominant eyes (n=52)	Nondominant eyes (n=52)	P-value
Central Macular Thickness (mm)	192.538 (± 21.4361)	191.981 (± 20.1402)	0.892
		ONH Parameters	
Disk area (mm^2)	3.20 (± 0.58)	3.21 (± 0.62)	0.925
Rim area (mm^2)	2.49 (± 0.67)	2.52 (± 0.58)	0.835
Vertical C/D ratio	0.41 (± 0.17)	0.40 (± 0.16)	0.778
Horizontal C/D ratio	0.41 (± 0.20)	0.43 (± 0.20)	0.714
Maximum cup depth (μm)	0.33 (± 0.21)	0.30 (± 0.19)	0.487
Average cup depth (μm)	0.15 (± 0.12)	0.12 (± 0.07)	0.198
		PRNFL thicknesses	
Average (μm)	110.37 (± 9.82)	110.65 (± 9.63)	0.880
		Quadrant analysis	
Superior (μm)	137.86 (± 17.24)	142.96 (± 16.17)	0.123
Inferior (μm)	140.00 (± 15.77)	139.51 (± 16.28)	0.879
Temporal (μm)	74.17 (± 10.97)	74.53 (± 12.06)	0.872
Nasal (μm)	91.15 (± 17.70)	87.80 (± 14.98)	0.301

C/D ratio, cup to disk ratio.
PRNFL, peripapilary retinal nerve fiber thickness in μm.
Means that significantly different between each eye are in bold ($p<0.05$, Kolmogorov-Smirnov test).

Discussion

Ocular dominance is usually defined as the superiority of one eye over the other in some sensory or motor tasks. In dominant eye images appear clearer, more stabilized than non--dominant eye. Importance of determination of ocular dominance come up with in the monovision management of presbyopia with cataract surgery, contact lenses and LASIK. [5-11]

To determine the ocular dominance there are several methods. We used hole-in-the-card test because this is an practical, repeatable and reliable test for ocular dominance detection.

Diagnosing of glaucoma in early stage is very important. If glaucoma is detected and treated early, visual prognosis is perfect. Inter ocular pressure, cup to disc ratio and visual field have been used to detect the glaucoma. In recent years, PRNFL measuring with OCT has became more popular. PRNFL is one of the first structures to be damaged. PRNFL thickness is the most important parameter for detecting and following. Age, ethnicity, axial lenght, optic disc area and inter-ocular differences can affect the normal PRNFL profile. [12-14] PRNFL thickness asymmetry was reported in healthy adults between left and right eyes. The most important deficiency of this area is cutoff value. After determination of cutoff value for normal interocular difference in PRNFL thickness, it may help in early detection of glaucoma.

In previous studies, superior quadrant PRNFL thickness was found thicker in left eye than right eye.[3,15] Budenz et al. and Park et al. found the average PRNFL of the right eye was significantly thicker than that of the left eye.[12, 14] We found same results in average and superior quadrant analysis. Either our study or other studies showed that the other three quadrant (nasal, temporal and inferior) PRNFL thickness was detected thicker in right eyes than left but there was no significant difference. In the Sydney Childhood Eye Study, their results were similar to us, they did not found the significant difference between two eyes. [15] Parallel the our study Mwanza et al. showed that left eyes has thicker superior quadrant PRNFL than right eye.[3] Essock et al and Kurimoto et al measured the PRNFL thickness with scanning laser polarimetry and they did not found significant difference between left and right eyes.[16, 17] The other scanning laser polarimetry study was done by Gherghel and associates, they measured the PRNFL thickness in 314 normal eyes of 117 subjects. Their results were statistically significant in interocular differences in the average and nasal PRNFL thickness which were thicker in left eyes. [18]

There was few study which compared PRNFL asymmetry in dominant and non-dominant eyes. Choi et al found inferior PRNFL was thicker than superior PRNFL in the dominant eyes. [19] In our results superior quadrant PRNFL thickness of dominant eye was thinner than non-dominant eye and nasal quadrant PRNFL thickness of dominant eye was thicker than non-dominant eye. In February 2016, Korean young participants were analysied. This study results showed us that dominant eyes had a significantly thicker average, temporal, and nasal PRNFL thickness, on the other hand non-dominant eyes had thicker superior PRNFL thickness compared to dominant eyes. [20] These differences might be associated with Turkish and Korean population difference. Also in their study Korean young population was moderate myopia but in our study Turkish population was emmetropia.

We hypothesized that PRNFL profile may be affected by ocular dominance. But our results showed us that ocular dominance does not affect the differences in interocular and intraocular PRNFL thickness statistically.

The relationship of the ocular dominance and macular disorders is very important.

For example in the macular hole which is in the dominant eye, patient suffers more visual handicap than non-dominant eye's macular hole. [21]

We also searched CMT differences between the eyes. Our results showed us macular thickness difference was not associated with ocular dominance. In previous studies, most authors did not find any association between CMT and ocular dominance. For example Park et al. reported that cone packing density differences were not assciated with ocular dominance.[22] In the Sydney Myopia Study, Samarawickrama et al. investigated CMT and ocular dominance connection in 4118 children. They

did not found statistically significant interocular difference.[23] From Turkey, Pekel et al. reported that they did not found any association between differences in interocular and intraocular macular thickness with ocular dominance.[24]

Conversely, Dickmann et al. found that amblyopic eyes in a strabismic group showed significantly thinner macular thickness compared to fellow eyes.[25]

There are several limitations to our study. The first limitation is that the sample size of the study was relatively small. Second, study participants were all young adult Turkish population. Last, all participants were emmetropic. PRNFL and CMT values might show different results in myopic or hypermetropic patients.

Conclusions

No difference between macular and peripapillary retinal nerve fiber layer thicknesses were detected in dominant and non-dominant eyes. Further evaluation is needed.

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