Original Article

Correlation of visual functions with macular thickness in primary open angle glaucoma

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Aim: The aim of this study was to establish a correlation between macular thickness on optical coherence tomography (OCT) and 2 visual functions (visual acuity and contrast sensitivity [CS]) in established cases of primary open angle glaucoma (POAG).

Materials and Methods: A total of 50 consecutive patients of established POAG between 40 years and 70 years of age attending the glaucoma clinic of a tertiary care eye center in North India were enrolled for this cross-sectional study. Best corrected visual acuity (BCVA), CS and macular thickness by spectral-domain-OCT (Cirrus HD-OCT, CarlZeiss, Germany) were evaluated.

Statistical Analysis: The groups were compared together by one factor analysis of variance and the significance of mean difference between the groups was done by Newman-Keuls test.

Results: Newman-Keuls test revealed a direct relationship of macular thickness to BCVA and CS ($P < 0.05$).

Conclusion: BCVA and CS are directly related to the macular thickness on OCT.

Keywords: Contrast sensitivity, macular thickness, optical coherence tomography, primary open angle glaucoma, visual acuity

Introduction

Studies in the past have shown that visual functions are affected in patients of primary open angle glaucoma (POAG).[1-3] Recently, some researchers have demonstrated macular thinning in the early phase of POAG.[1,4-8] This study aims to establish a relationship, if any between macular thickness and 2 visual functions (visual acuity and contrast sensitivity[CS]).

Materials and Methods

A total of 50 consecutive patients of established[9] POAG between 40 years and 70 years of age attending the glaucoma clinic of a tertiary care eye center in North India were enrolled for this cross-sectional study after taking informed consent. Patients with signal strength <8/10 on OCT, any macular disease or high refractive errors[9] (>±6.00 diopters (D) spherical and >±3.00 Dcylindrical) were excluded.

The selected patients underwent a detailed ophthalmic examination including best corrected visual acuity (BCVA) on LogMAR chart and CS on Pelli Robson chart. For analyzing the macular thickness in relation to visual acuity, patients were divided into 3 groups on the basis of WHO working definition of vision for BCVA[10] and National Research Council Recommendations for CS (Visual Impairment: Determining Eligibility for Social Security Benefits, National Research Council 2002).

Macular thickness was measured by spectral-domain OCT (SD-OCT) (CirrusHD-OCT, CarlZeiss, Germany) macular cube 512 × 128 in 9 quadrants for each patient.[9] An average of the 9 readings was taken as the macular thickness for that patient. A mean of the macular thickness of all patients in each subgroup was calculated and taken up for statistical analysis.

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Statistical analysis

The groups were compared together by one factor analysis of variance and the significance of mean difference between the groups was carried out by Newman-Keuls test. $P < 0.05$ was considered as statistically significant. The comparison between the actual variation of the group averages and that expected from the above formula was expressed in terms of F. All analyzes were performed on STATISTICA (window version 6.0).

Results

Out of 100 eyes of cases, 93 eyes were considered for analysis as 7 eyes either had poor vision or signal strength <8/10 on OCT. The results are summarized in Tables 1 and 2.

Discussion

Various studies have shown that the prevalence of POAG increases with age in all depicted ethnicities.[11] Hence in accordance with the previous data, cases were selected in the age group of 40-70 years as glaucoma is the disease of middle age; thus, the sample represented the affected population.

The recent advent of SD-OCT has renewed interest in the potential uses of macular imaging in glaucoma due to its ability to better segment and measure individual retinal layers. Multiple studies have been performed in the last few years to investigate the diagnostic ability, reproducibility, and limitations of these new SD-OCT macular parameters. Overall, SD-OCT has been shown to have higher reproducibility than Time Domain (TD)-OCT, and the majority of studies seem to concur that the diagnostic sensitivity of SD-OCT macular parameters is atleast comparable to TD-OCT and other SD OCT parameters.[12] This system allows a faster acquisition time than the conventional time domain OCT; thus allowing a larger number of images to be acquired resulting in scans of higher resolution and three dimensional analysis.[13]

The Pelli-Robson chart represents an easily available method of measuring spatial CS that is compatible with clinical practice. Accordingly, we chose to use this modality for the study.

To the best of our knowledge, there have been no studies relating the visual acuity and CS with macular thickness. The data clearly depicts macular thickness in a direct and significant ($F = 9.81$, $P = 0.0001$) correlation with visual acuity. As the disease progression involves the ganglion cell complex,[6] it manifests as diminution of the visual acuity which when exaggerated, signals the involvement of the papillomacular bundle detected as macular thinning on OCT.

There are various studies[2,3] correlating CS with visual fields, but none have talked about its relation with macular thickness. This study found a significant reduction ($F = 17.00$, $P < 0.0001$) in macular thickness with decreasing CS pointing to the involvement of the macula as a high possibility. This is an important finding because CS testing is highly dependent on the literacy level and cooperation of the patient. Therefore, macular thickness can be used as a tool to monitor the disease in patients uncooperative for CS testing.

The exclusion of patients with poor vision and media opacities was the main study limitation.

We can conclude that the visual acuity and CS are directly related to the macular thickness on OCT. Macular thickness on OCT could be an important tool to evaluate the stage and monitor progression of POAG, particularly, in patients where reliable assessment of visual acuity and CS is difficult. More studies would be required to extend these findings into regular clinical practice.

Table 1: Relationship between mean macular thickness and BCVA

BCVA	Mean macular thickness±SD (n=93)	F value (2,90DF)	P value
0.00-0.48	263.77±13.83 (52)	10.05	0.0001
>0.48-1.00	229.08±7.68 (37)		
>1.00	220.08±7.68 (4)		

Numbers in parenthesis indicates number of eyes. Newman-Keuls test revealed that macular thickness decreased significantly with poorer BCVA, i.e., decreased significantly in cases with BCVA of 0.48-1.00 ($P<0.05$) and >1.00 ($P<0.001$) as compared to those with BCVA of 0.00-0.48. The intergroup comparison revealed a $P<0.05$ when one group was compared to any other group, establishing a direct relationship between macular thickness and visual acuity, BCVA: Best corrected visual acuity

Table 2: Relationship between mean macular thickness and contrast sensitivity

Contrast sensitivity groups	Mean macular thickness±SD (n=93)	F value (2,90DF)	P value
>1.50	271.44±10.83 (42)	18.03	<0.0001
1.05-1.50	260.42±16.46 (39)		
<1.05	237.06±33.63 (12)		

Numbers in parenthesis indicates number of eyes, Newman-Keuls test revealed that macular thickness in cases with CS between 1.05-1.50 and >1.50 decreased significantly ($P<0.001$) when compared to those with CS <1.05 and also decreased when compared amongst themselves ($P<0.05$), implicating a direct relationship between macular thickness and CS, CS: Contrast sensitivity

References

1. Stamper RL. The effect of glaucoma on centralvisual function. Trans Am Ophthalmol Soc 1984;82:792-826.
2. Wilensky JT, Hawkins A. Comparison of contrast sensitivity, visual acuity, and Humphrey visual field testing in patients with glaucoma. Trans Am Ophthalmol Soc 2001;99:213-7.
3. Greenfield DS, Bagga H, Knighton RW. Macular thickness changes in glaucomatous optic neuropathy detected using optical coherence tomography. Arch Ophthalmol 2003;121:41-6.
4. Tan O, Li G, Lu AT, Varma R, Huang D; Advanced Imaging for Glaucoma Study Group. Mapping of macular substructures with optical coherence tomography for glaucoma diagnosis. Ophthalmology 2008;115:949-56.
5. Stefan C, Dumitrica DM, Tebeanu E, Cristea I, Sapundgieva A, Dragomir L, *et al*. Macular involvement in glaucoma. Oftalmologia 2008;52:98-101.
6. Tan O, Chopra V, Lu AT, Schuman JS, Ishikawa H, Wollstein G, *et al*. Detection of macular ganglion cell loss in glaucoma by Fourier-domain optical coherence tomography. Ophthalmology 2009;116:2305-14.e1-2.
7. Sakamoto A, Hangai M, Nukada M, Nakanishi H, Mori S, Kotera Y, *et al*. Three-dimensional imaging of the macular retinal nerve fiber layer in glaucoma with spectral-domain optical coherence tomography. Invest Ophthalmol Vis Sci 2010;51:5062-70.

8. Kanis MJ, Lemij HG, Berendschot TT, van de Kraats J, van Norren D. Foveal cone photoreceptor involvement in primary open-angle glaucoma. Graefes Arch Clin Exp Ophthalmol 2010;248:999-1006.
9. Kanadani FN, Hood DC, Grippo TM, Wangsupadilok B, Harizman N, Greenstein VC, *et al*.Structural and functional assessment of the macular region in patients with glaucoma. Br J Ophthalmol 2006;90:1393-7.
10. WHO working definition of vision. Recommendation of WHO Consultation at Bankok; July 1992. p. 23-4.
11. Friedman DS, Wolfs RC, O'Colmain BJ, Klein BE, Taylor HR, West S, *et al*. Prevalence of open-angle glaucoma among adults in the United States. Arch Ophthalmol 2004;122:532-8.
12. Wong JJ, Chen TC, Shen LQ, Pasquale LR. Macular imaging for glaucoma using spectral-domain optical coherence tomography: A review. Semin Ophthalmol 2012;27:160-6.
13. Saxena S, Singh K. Three-dimensional retinal imaging in spectral domain optical coherence tomography. In: Saxena S, Sadda S, editors. Emerging Technologies in Retinal Diseases. New Delhi: Jaypee Medical Publishers; 2009. p. 67-122.

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