Research Article

Evaluation of changes in retinal fiber layer thickness in pseudoexfoliation syndrome using spectral domain optical coherence tomography

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Received: January 27, 2018; **Accepted:** March 29, 2018

ABSTRACT

Background: Pseudoexfoliation syndrome (PEX) is a disorder characterized by the progressive accumulation of fibrillary extracellular deposits in several ocular tissues including the iris, anterior chamber angle, lens capsule, and zonules. It is an independent risk factor for glaucomatous optic nerve damage. Retinal nerve fiber layer thickness analysis using optical coherence tomography (RNFL-OCT) is a documented investigative tool to detect preperimetric glaucoma and helps to detect glaucoma early. **Objective:** The objective of this study was to evaluate the retinal nerve fiber thickness in eyes with PEX using OCT and to compare them with healthy controls. **Materials and Methods:** This prospective cross-sectional control study was conducted at GMC, Srinagar, in which retinal nerve fiber thickness 50 patients of PEX and 50 healthy control subjects were compared using Cirrus spectral domain OCT (Carl Zeiss). Complete ocular and physical examination was also done in all subjects. **Results:** Mean age of Group A (PEX group) was 59.06 ± 6.5 years and of Group B (control) was 57.04 ± 7.1 years (P = 0.51). Both groups were gender matched with male preponderance (P = 0.41). Mean average peripapillary RNFL thickness was 76.13 μm ± 13.65 in Group A (PEX group) and 82.61 ± 12.78 μm in Group B (control group) (P = 0.10). Mean superior RNFL thickness was 94.17 ± 16.25 in PEX group and 100.23 μm ± 13.21 in control group (P = 0.09). Mean inferior RNFL thickness was 89.67 μm ± 18.25 in PEX group and 102.45 μm ± 12.50 in control group (P = 0.03). Mean nasal RNFL thickness was 62.36 μm ± 15.36 in PEX group and 64.66 μm ± 13.71 (P = 0.56) in control group. Mean temporal RNFL thickness was 58.34 μm ± 14.32 in PEX group and 63.11 μm ± 15.25 (P = 0.08) in control group. Mean RNFL thickness was seen decreased in all PEX patients in all quadrants; however, statistically significant differences were detected only in inferior quadrant groups. **Conclusion:** RNFL thickness is decreased in PEX patients. SD-OCT is a very reliable investigative tool to measure RNFL thickness, which helps in detecting preperimetric glaucoma.

KEYWORDS: Pseudoexfoliation Syndrome; Glaucoma; Retinal Nerve Fiber

INTRODUCTION

Pseudoexfoliation (PEX) syndrome is a genetically determined and age-dependent, generalized disorder of the elastic fiber system.[1,2] PEX is the most important identifiable risk factor for open-angle glaucoma, and PEX glaucoma accounts for 25% of all open-angle glaucomas worldwide.[3,4] In this condition, there is abnormal deposition of extracellular fibrillary material on many ocular and extraocular tissues including the periphery of blood vessels.[1,2]

Access this article online	
Website: http://www.ijmsph.com	Quick Response code
DOI: 10.5455/ijmsph.2018.0103530032018	

Structural damage of optic nerve head and RNFL in glaucoma may precede functional loss. About 30–50% of retinal ganglion cells may be lost before any visual fields changes are detected.[5-7] SD-OCT is a computerized imaging technology that produces high resolution, quantitative and reproducible measurements of RNFL, and retinal ganglion

cell complex and helps in differentiating normal eyes from patients with early glaucoma.[5,7]

The objective of this study was to evaluate the peripapillary RNFL using SD-OCT in PEX patients and healthy subjects.

MATERIALS AND METHODS

This prospective cross-sectional study was conducted in Government Medical College, Srinagar, Jammu and Kashmir, India, in the Postgraduate Department of Ophthalmology.

The study was conducted in accordance with the ethical consideration given in Helsinki. A written consent was obtained from the patients. The study included 50 eyes of 50 healthy subjects and 50 eyes PEX patients.

The diagnosis of PEX was made by the presence of following findings: PEX material on the lens capsule or near the pupil; transillumination defects near the pupil; increased pigmentation or PEX material at the angle, or both. An eye was considered normal if it had an IOP of <21 mmHg, an optic disc with normal ophthalmoscopic appearance and normal visual field test results.

All participants underwent a complete ocular examination. Biomicroscopic and fundoscopic examination with a 90-dpt lens was performed, and IOP was measured using a Goldmann applanation tonometer. Ocular axial length was measured using Ultrasound US-4000 (Nidek Co., Ltd., Japan). Visual field evaluation was done using the 30-2 SITA-Standard algorithm (Humphrey Visual Field Analyser; Carl Zeiss Meditech, USA). CT was measured by Cirrus 5000 spectral domain OCT (Carl Zeiss Meditech, USA).

Exclusion criteria were as follows: History or evidence of any ocular disease such as age-related macular degeneration, diabetic retinopathy, central serous chorioretinopathy, epiretinal membrane, and macular dystrophy; best-corrected visual acuity of <20/25; history of intraocular surgery, trauma, and ocular inflammation; evidence of glaucoma; and poor image due to cataract, refractive errors (myopia or hyperopia) >3 dpt, and astigmatism >1.5 dpt.

Subjects with systemic diseases or conditions were also excluded, such as diabetes mellitus, cardiovascular disease, dyslipidemia, renal failure, malignancy, autoimmune diseases, hematological diseases, chronic obstructive pulmonary disease, uncontrolled arterial hypertension, a history of transient ischemic attack or stroke, and a history of smoking as they might affect retinal thickness.

OCT measurements were performed using Cirrus HD OCT 5000 (Carl Zeiss Meditec, Dublin, CA) after pupillary dilatation. Images with visible eye motion, blinking artifacts, and those with signal strength <6 were excluded. At optic disc cube protocol, 6 mm × 6 mm area was scanned with 200 × 200 axial scan (A-scan).

Average cup/disc (C/D) ratio and vertical C/D ratio were calculated. RNFL thickness was measured by scanning three consecutive 360° circular scans with a diameter of 3.4 mm centered on the optic disc. Mean RNFL thickness and average RNFL thickness in four quadrants (superior, nasal, inferior, and temporal) were calculated automatically.

All data were analyzed using SPSS software (version 17.0; SPSS Inc., Chicago). The descriptive statistics were presented as mean ± standard deviation. The independent samples t-test was used to compare the groups. The ×2 test was used to make comparisons between the sexes. $P < 0.05$ was considered statistically significant.

RESULTS

Demographic and clinical characteristics of PEX and control groups are summarized in Table 1. Mean age of Group A (PEX patients) was 59.06 ± 6.5 years and of Group B (control) was 57.04 ± 7.1 years ($P < 0.51$), and most of the patients were in the range of 51–60 years [Figure 1]. Both groups were gender matched with male preponderance [Figure 2]. Mean IOP, refractive error, and axial length were

Table 1: Patients and control demographic data

Parameters	*n*=50		*P* value
	PEX	Control	
Age (years) Mean±SD	59.06±6.5	57.04±7	0.51
Gender (male/female)	30/20	26/24	0.41
IOP mmHg	15.6±2.4	14.8±3.1	0.21
Refractive error (D)	−1.6±1.1	−1.2±1.2	0.29
Axial length (mm)	22.46±1.4	22.64±1.2	0.41

PEX: Pseudoexfoliation, SD: Standard deviation

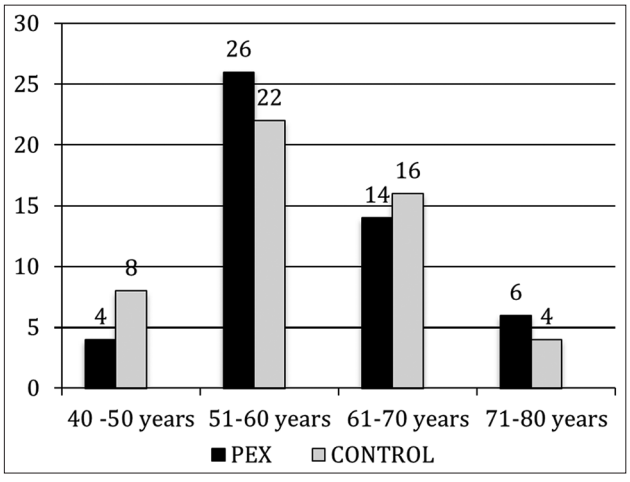

Figure 1: Age distribution

comparable in both PEX and control group. Mean IOP in PEX group was 15.6 ± 2.4 mmHg and 14.8 ± 3.11 mmHg in control group ($P < 0.21$). Mean refractive error in PEX patients was −1.6 ± 1.1 D and −1.21 ± 1.2 D in control group ($P < 0.29$). Mean axial length in PEX patients was 22.46 ± 1.4 mm and 22.64 ± 1.2 mm in control group ($P<0.41$).

The mean RNFL measurements at each location are shown in Table 2. Mean average peripapillary RNFL thickness was 76.13 ± 13.65 μm in PEX Group A and 82.61 ± 12.78 μm in control Group B ($P < 0.10$). Mean superior RNFL thickness was 94.17 ± 16.25 μm in PEX Group A and 100.23 ± 13.21 μm in control Group B ($P < 0.09$). Mean inferior RNFL thickness was 89.67 ± 18.25 μm in PEX group and 102.45 ± 12.50 μm in control group ($P < 0.03$). Mean nasal RNFL thickness was 62.36 ± 15.36 μm in PEX group and 64.66 ± 13.71 μm ($P < 0.56$) in control group. Mean temporal RNFL thickness was 58.34 ± 14.32 μm and 63.11 ± 15.25 μm ($P < 0.08$). Mean RNFL thickness was seen decreased in all PEX patients in all quadrants; however, statistically significant differences were detected only in inferior quadrant groups.

DISCUSSION

PEX is the ocular manifestation of a systemic disease; therefore, pseudoexfoliative material deposits are not only found within orbital tissue but can also accumulate in different part of the body such as skin, lung, heart, liver, gallbladder, kidney, ear, optic nerve, blood vessels, and cerebral meninges.[8,9]

Table 2: Distribution of peripapillary RNFL thickness

Quadrants	Mean±SD		*P* value
	PEX (n=50)	Control (n=50)	
Superior (μm)	94.17±16.25	100.23±13.21	0.09
Inferior (μm)	89.67±18.25	102.45±12.50	0.03
Nasal (μm)	62.36±15.36	64.66±13.71	0.56
Temporal (μm)	58.34±14.32	63.11±15.25	0.08
Average (μm)	76.13±13.65	82.61±12.78	0.10

RNFL: Retinal nerve fiber layer

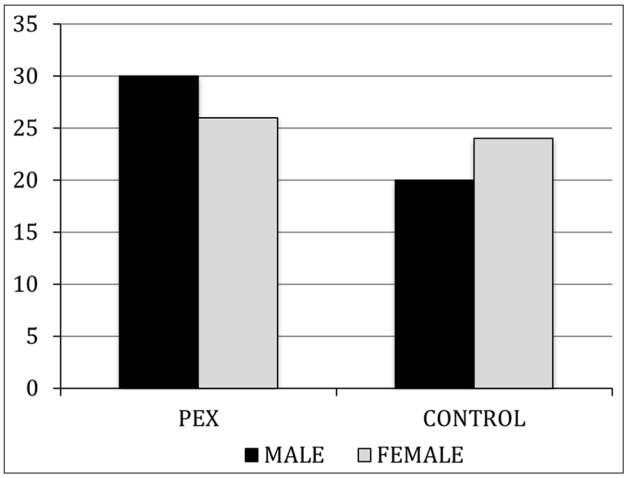

Figure 2: Gender distribution

Optic disc evaluation by slit lamp biomicroscopy or photography is subjective and causes interobserver variability. Visual field analysis to detect glaucomatous optic nerve damage is a gold standard investigation; however, there must be at least 40% loss in retinal ganglion cells before any abnormal visual field tests results are detected.[10]

OCT is a newer imaging technology that provides high-resolution quantitative analysis of retinal nerve fiber and retinal ganglion cells.[5,7] The study conducted by Lisboa *et al*. found that SD-OCT was able to discriminate eyes with preperimetric glaucoma from those with suspected glaucoma.[11]

PEX prevalence increases with age markedly with age[12] and shows a male preponderance as shown by various studies.[13-16] In our study, 60% patients in PEX group were males with mean age of 59.06 ± 6.5 years, which was similar to other studies.

Our study revealed thinner mean average peripapillary RNFL thickness (76.31 μm vs. 82.61μm) and mean RNFL thickness in all quadrant quadrants in patients having PEX with normal IOP as compared with age-matched healthy adults using SD-OCT. However, statistically significant difference was only detected in inferior quadrant only. Sorkhabi *et al*.[17] found that average RNFL thickness in PEX patients was thinner than healthy subjects but found no significant difference between PEX and healthy subjects in RNFL thicknesses according to quadrants. Yüksel *et al*. found that RNFL in patients with PEX was significantly thinner than controls in all quadrants except the nasal quadrant.[18] Moreover, they found significantly lower RNFL thickness in the inferior quadrant in PXF eyes compared to non-PEX eyes that were similar to our results.

Ozmen *et al*.[13] also reported significantly thinner average and inferior quadrant RNFL in PXF group as compared to control group which was similar to our study. Rao *et al*.[19] showed that in non-exfoliative eyes of unilateral PEX, RNFL thickness is in border limits in any quadrant using OCT. Yasmeen *et al*.[20] reported a significant thinner average RNFL in PEX in inferior quadrant similar to our study. However, they reported a significant decrease in average RNFL, which was not seen in our study.

Most of the results of our study were similar to various other studies. However, there were some differences that may be due variation in age, ethnicity, and gender and using different machines.

CONCLUSION

Our study found that there is decrease in RNFL thickness in PEX patients. SD-OCT is a very reliable investigation to calculate RNFL thickness and helps to diagnose preperimetric glaucoma.

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How to cite this article: Nawaz S, Sofi RA, Querishi T. Evaluation of changes in retinal fiber layer thickness in pseudoexfoliation syndrome using spectral domain optical coherence tomography. Int J Med Sci Public Health 2018;7:529-532.

Source of Support: Nil, **Conflict of Interest:** None declared.