

# Central Corneal Thickness, Corneal Endothelial Cell Density, and Lens Capsule Thickness in Normotensive Patients with and without Pseudoexfoliation Syndrome

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## Abstract

**Purpose:** To compare central corneal thickness (CCT), corneal endothelial cell density, and lens capsule thickness in normotensive patients with and without pseudoexfoliation syndrome (PXS)

**Methods:** This was a prospective, comparative, descriptive study. Normotensive candidates for cataract surgery with (study group) and without (control group) PXS were enrolled in the study. CCT and corneal endothelial cell density were measured preoperatively, and central lens capsule thickness was measured postoperatively.

**Results:** Forty-three eyes of 43 patients in the study group and 39 eyes of 39 age-matched patients in the control group were studied. The mean age was 68.6±11.2 years and 69.3±13.1 years in the PXS and control group, respectively (P=0.5). The mean CCT was 511.9±27.9 µm in the PXS group and 531.4±32.7 µm in the control group (P=0.005). The mean central endothelial cell density was 2045±493 cell/mm<sup>2</sup> in the PXS group and 2098±431 cell/mm<sup>2</sup> in the control group (P=0.57). In the PXS group, the mean lens capsule thickness was 15.85±3.31 µm, and it was 15.27±3.35 µm in the control group (P=0.4).

**Conclusion:** The mean CCT in PXS group was significantly lower than control group. However, there were no significant differences between corneal endothelial density and anterior lens capsule thickness between PXS group and control group.

**Keywords:** Capsular Thickness, Corneal Thickness, Corneal Endothelial Cell Density, Pseudoexfoliation

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## Introduction

Pseudoexfoliation syndrome (PXS) is a well-known entity that was first described by Lindberg in 1917.<sup>1</sup> This syndrome may be the most frequently overlooked entity in the anterior segment of the eye. This syndrome, which can usually be diagnosed by visualization of characteristic fibrillogranular material on the anterior lens capsule and/or on the pupillary margin in slit-lamp examination,<sup>2</sup> predisposes the eye to the many intra- and postoperative complications.

The complications associated with PXS include secondary open angle glaucoma, increased frequency of phacodonesis and lens subluxation, increased incidence of vitreous loss during cataract surgery, blood aqueous barrier breakdown with a change in the composition of aqueous humor and subsequently changing of metabolism of corneal endothelium, anterior chamber hypoxia, melanin dispersion, poor pupillary dilation, and posterior synechiae formation.<sup>2-6</sup> Furthermore, it has been reported that, compared with control eyes, central corneal thickness (CCT) is significantly thinner in normotensive PEX eyes and significantly thicker in glaucomatous PXS eyes.<sup>3</sup> Specular microscopic studies have shown significantly reduced corneal endothelial cell density in eyes with PXS even without glaucoma, as well as morphologic alteration in the size and shape of corneal endothelial cell.<sup>4,7</sup> Ultrastructural changes have also been confirmed in lens capsule, zonules, iris tissue, ciliary body, trabecular meshwork, and in the vessels of conjunctiva and orbits of these patients.<sup>8</sup>

Elucidating the anterior segment findings of eyes with PXS could be helpful in better understanding of the pathogenesis of PXS, and also, in determining the risks which are associated with any surgical intervention in this patients. In this study, we evaluated CCT, central corneal endothelial cell density, and central anterior lens capsule thickness in eyes with pseudoexfoliation, and compared them with eyes without pseudoexfoliation.

## Methods

This was a prospective, comparative, descriptive study conducted on a group of patients with PXS (study group) and a group of age-matched patients without PXS (control

group) who underwent cataract surgery in Farabi Eye Hospital, Tehran, Iran. All patients in these two groups had normal (<21 mmHg) intraocular pressure (IOP) without any evidence of glaucoma. In addition, patients with previous intraocular surgery or evidence of corneal disease such as guttata were excluded from the study. At baseline, all patients underwent a detailed ophthalmologic examination including slit-lamp biomicroscopy and Goldmann applanation tonometry. Diagnosis of PXS was based on the clinical finding of characteristic fibrillogranular material on the anterior lens capsule and/or pupillary margin. In all cases of both groups, central corneal endothelial density was evaluated by specular microscope (Nidek SP2000T, Nidek Co, Hiroishi, Gamagori, Japan) and CCT was measured by ultrasound pachymeter (Tomey-SP 2000, Tomey Co, Nagoya, JAPAN). Patients then underwent phacoemulsification; and central anterior capsules which were obtained by central 5-6 mm continuous curvilinear capsulorrhexis were collected and sent in 10% formalin solution for thickness measurement by an experienced pathologist (F AA). Briefly, after processing, histology sections were cut in 4  $\mu$ m thickness and the slides were stained by hematoxylin-eosin method. Capsular thickness was then measured by a calibrated light microscope (Zeiss Axiostar Plus, Carl Zeiss Inc, Germany). The average, minimum, and maximum lens capsule thickness were measured.

Statistical analysis was performed using SPSS for Windows version 12 (SPSS Inc., Chicago, IL). Student t-test was used to compare parametric continuous values between the two groups. Pearson correlation coefficient and contingency coefficient tests were used to evaluate any correlation between parametric continuous variables and categorical variables, respectively. For all measurements, a two-tailed test was used and a p value of <0.05 was considered significant for measured variables.

## Results

The PXS group included 43 eyes of 43 patients; of them 15 cases (35%) were females. The control group comprised of 39 eyes of 39 patients; of them 21 cases (59%)

were females. The mean age was  $68.6 \pm 11.2$  years (range, 42-87 years) in the PXS group and  $69.3 \pm 13.1$  years (range, 37-89 years) in the control group ( $P=0.5$ ). The mean CCT was  $511.9 \pm 27.9$   $\mu\text{m}$  (range, 448-571  $\mu\text{m}$ ) in the PXS group and  $531.4 \pm 32.7$   $\mu\text{m}$  (range, 487-605  $\mu\text{m}$ ) in the control group ( $P=0.005$ ). In the PXS group, the mean corneal endothelial cell density was  $2045 \pm 493.68$  cell/ $\text{mm}^2$  (range, 1200-3088 cell/ $\text{mm}^2$ ), and it was  $2098.28 \pm 431.18$  cell/ $\text{mm}^2$  (range, 979-2786 cell/ $\text{mm}^2$ ) in the control group ( $P=0.57$ ).

The mean anterior lens capsule thickness did not show any statistically significant difference between the two groups, as it was  $15.85 \pm 3.31$   $\mu\text{m}$  (range, 11-25  $\mu\text{m}$ ) in the PXS group and  $15.27 \pm 3.35$   $\mu\text{m}$  (range, 10-28  $\mu\text{m}$ ) in the control group ( $P=0.4$ ) (Table 1).

Although the difference in minimum lens capsule thickness between the two groups was statistically significant [ $12.91 \pm 4.00$   $\mu\text{m}$  in PXS group vs.  $11.81 \pm 2.32$   $\mu\text{m}$  in control group, ( $P=0.009$ )], there was no statistically significant difference between these two groups in terms of maximum lens capsule thickness [ $21.12 \pm 8.06$   $\mu\text{m}$  vs.  $20.67 \pm 4.40$   $\mu\text{m}$  in PXS and control group, respectively ( $P=0.76$ )].

There was not any correlation between age and CCT, central corneal endothelial cell density, and central lens capsule thickness in PXS and non-PXS patients. There was not also any correlation between sex and CCT, central corneal endothelial cell density, and central lens capsule thickness in PXS and non-PXS patients.

**Table 1.** Central corneal thickness, central corneal endothelial cell density, and central anterior capsule thickness in eyes with and without pseudoexfoliation syndrome

Variable	PXS group	Control group	P
Central corneal thickness ( $\mu\text{m}$ )	$511.9 \pm 27.9$	$531.4 \pm 32.7$	0.005
Corneal endothelial cell density (cell/ $\text{mm}^2$ )	$2045 \pm 493$	$2098 \pm 431$	0.573
Anterior capsular thickness ( $\mu\text{m}$ )			
Average	$15.85 \pm 3.31$	$15.27 \pm 3.35$	0.4
Minimum	$12.91 \pm 4.00$	$11.81 \pm 2.32$	0.009
Maximum	$21.12 \pm 8.06$	$20.67 \pm 4.40$	0.76

PXS: Pseudoexfoliation syndrome

## Discussion

PXS is an entity with a strong familial association, and recently, the lysyl oxidase-like 1 gene has been associated with this disorder. Since this gene is involved in the synthesis and maintenance of elastic fibers, there is a biological rationale for being involved in pathogenesis of this disorder.<sup>9</sup> Even though multiple inheritance patterns have been suggested for PXS, a clear inheritance pattern is not evident.

This entity is of considerable clinical importance, because it is frequently associated with open angle glaucoma, lens subluxation and a higher incidence of surgical complications during cataract surgery,<sup>2-6,10</sup> the latter is mostly due to three clinically important features in eyes with PXS: small pupil, weak zonules, and peripheral iridocapsular adhesion.<sup>11</sup>

Stable capsular bag, which is formed by the integrity of zonular fibers and posterior lens capsule, is needed for intraocular lens implantation. Because these may be compromised in PXS, this syndrome should always be considered preoperatively. To be prepared for intraoperative complications, ultrasound biomicroscopy (UBM) is an additional tool which provides detailed images of the anterior chamber angle, iris, ciliary body, lens, zonules, and pars plana.<sup>8</sup>

Bartholomew considered radial, peripheral, and gray striation of the anterior lens capsule to be the earliest biomicroscopic change in PXS and termed the condition as "pregranular stage".<sup>12</sup> Dark et al, reported the presence of subtle opacified surface layer of anterior lens capsule in many older patients and suggested

this "precapsular film" to be precursor of PXS.<sup>13</sup>

We believe basic studies could help us in better understanding of pathogenesis and could unveil special features of them; which, in turn, could help in better detection and diagnosis of subclinical disorder. The principal aim of this study was to determine CCT, central corneal endothelial cell density, and central lens capsule thickness in eyes with and without PXS. For this purpose, 43 normotensive patients with PXS and 39 non-PXS patients were selected. It was found that although the central corneal endothelial cell density was not different in these two groups, the eyes with PXS had significantly lower CCT than non-PXS eyes [ $511.9 \pm 27.9 \mu\text{m}$  vs.  $531.4 \pm 32.7 \mu\text{m}$ , respectively, ( $P=0.005$ )]. Moreover, there was no significant difference in the mean central lens capsule thickness between the groups.

The finding of lower CCT in eyes with PXS is compatible with some previous studies. Inoue et al, reported that CCT in PXS group was significantly lower than normal group.<sup>7</sup> Several studies have shown an average CCT of about 517-524  $\mu\text{m}$  in normal eyes.<sup>4,5,14</sup> However, higher values of 545-561  $\mu\text{m}$  have also been reported in normal eyes.<sup>15,16</sup> In this study, eyes with PXS had a mean CCT value of  $511.9 \pm 27.9 \mu\text{m}$ , which was significantly lower than control eyes ( $531.4 \pm 32.7 \mu\text{m}$ ) ( $P=0.005$ ).

This study found no significant difference in corneal endothelial cell density between eyes with and without PXS. The mean central endothelial density was  $2098 \pm 431 \text{ cells/mm}^2$  in non-PXS group and  $2045 \pm 493 \text{ cells/mm}^2$  in PXS group ( $P=0.57$ ). This is similar to the findings reported by Wirbelauer et al,<sup>17</sup> but in

contrast to some other studies which reported decreased corneal endothelial cell density, morphologic changes as well as keratopathy including endothelial decompensation in these patients.<sup>4,7,18</sup>

The previous data on capsular thickness in PXS is scanty. One study reported by Ruotsalainen showed a mean central anterior lens capsule thickness of  $8.2 \pm 3.2 \mu\text{m}$  for both normal and PXS patients.<sup>11</sup> In our study, the mean central lens capsule thickness was  $15.27 \pm 3.35 \mu\text{m}$  in the control eyes and  $15.85 \pm 3.31 \mu\text{m}$  in the PXS group. In addition, maximum central capsular thickness was  $21.12 \pm 8.06 \mu\text{m}$  in PXS group and  $20.67 \pm 4.40 \mu\text{m}$  in control eyes; and the minimum central lens capsule thickness in PXS group was  $12.91 \pm 4.00 \mu\text{m}$ , which was significantly higher than those in control eyes ( $11.81 \pm 2.32 \mu\text{m}$ ) ( $P=0.009$ ). In our study, there was not any association between the age and sex and other measured variables including CCT, central corneal endothelial cell density, and central lens capsule thickness. Even though we did not find any correlation between the age and central corneal endothelial cell density, this may be explained by a relatively small sample size of patients in each study group, which is one of the shortcomings of our study. We recommend conducting a prospective study with a larger sample size.

## Conclusion

It appears that the CCT in patients with PXS is less than patients without PXS, and that there is no difference in central corneal endothelial cell density and central lens capsule thicknesses between these patients.

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