ABSTRACT Introduction: Pseudoexfoliation in the eye is diagnosed by white, flaky, dandruff-like, fibrillo granular material on the pupillary margin or the anterior capsule of the lens. A characteristic “three-ring sign” is noted after pupillary dilatation on the anterior lens capsule. The presence of pseudoexfoliation (PEX) material in the anterior stromal layers of the cornea and a decrease in the stromal cell densities have been suggested to cause thinner CCT in eyes with PEX. The thinning is presumed to be due to apoptosis of the keratocytes. Aim: To evaluate Central Corneal Thickness in patients with Pseudoexfoliation syndrome and compare them with normal healthy controls. Material & Methods: The proposed case-control hospital-based study comprised 100 participants divided into two groups: Group I: Patients above 40 years of age, diagnosed with pseudoexfoliation syndrome on Slit-lamp examination. Group II: Healthy individuals above 40 years of age without pseudoexfoliation syndrome. Informed written consent was taken from all participants. In addition, other ophthalmic or systemic conditions which influence the corneal thickness measurement like Corneal dystrophies, degenerations, scars and post corneal refractive surgery, previous ocular surgery or ocular trauma, Glaucoma, Ocular hypertension, Uveitis, Systemic diseases like diabetes, or with ocular manifestations (collagen, skin, mucous membrane diseases), usage of topical medications which might affect the corneal conditions (esp. medications with preservatives), were excluded from the study. After a comprehensive ophthalmic examination, specular microscopy was performed on all study participants using TOPCON SP-1P Specular microscope to record central corneal thickness. Results: The mean Central Corneal Thickness (µm) obtained from specular microscopy in the PEX group was 487.34±27.16, while in controls, the mean Central Corneal Thickness (µm) recorded using specular microscopy was 505.09±26.36. The comparison of CCT (µm) between the PEX group and the Control group was statistically significant (p-value <0.0001). Conclusion: Pseudoexfoliation syndrome significantly affects the Central Corneal Thickness.

KEYWORDS Pseudoexfoliation Syndrome, Central Corneal Thickness, Specular Microscopy
mulation of PXM is either due to its excessive production and/or insufficient breakdown, and this is regarded as the pathognomonic hallmark of PXS. Genetically linked to the LOXL1 gene, PEX is a kind of elastosis[2]. Several non-genetic factors, including ultraviolet light exposure, dietary factors, infectious agents, trauma, and several stress conditions, like oxidative stress, hypoxia, and inflammation, have been suggested as co-modulating external factors in the development of PEX. The pathogenetic concept of PEX syndrome is an elastic microfibrillopathy that involves transforming growth factor-β1, oxidative stress, and impaired cellular protection mechanisms[3].

Hospital-based studies from India have reported a prevalence rate between 1.8 and 7.4% in adults over 45 years of age. Although there is no established sex predilection for PEX, a female preponderance has been previously reported.[4,5,6,7]

Pseudoexfoliation syndrome affects the cornea qualitatively and quantitatively. The normal thickness of the central cornea is 0.51 to 0.52 mm, which gets affected by various ocular conditions. Cases with PEX have significantly low Central Corneal Thickness, which may underestimate the IOP reading and overlook early glaucomatous damage. The presence of pseudoexfoliation material in the anterior stromal layers of the cornea and a decrease in the stromal cell densities have been suggested to cause thinner CCT in eyes with PEX. The thinning was presumed to be due to apoptosis of the keratocytes. David Maurice first described the specular microscope in 1968. Modifications to this specular microscope were made by Liang et al. and later by Bourne and Kaufman, allowing routine clinical examination and photography of the corneal endothelium. A specular microscope captures the specular reflection of light formed at the optical interface between the endothelium and the aqueous humour. It provides a large overlapping image of the endothelial cell layer, with higher magnification and less interface from the patient’s eye movement.

Procedure
The present study recorded Central Corneal Thickness (µm) in patients with Pseudoexfoliation syndrome. One hundred patients attending eye OPD were divided into two groups of 50 each. Group I included patients above 40 years of age who had pseudoexfoliation deposits in the eye as confirmed by slit-lamp examination. Group II comprised healthy individuals without pseudoexfoliation deposits that served as controls. Other ophthalmic or systemic condition which influences the corneal thickness measurement like Corneal dystrophies, degenerations, scars and post corneal refractive surgery, previous ocular surgery or ocular trauma, Glaucoma, Ocular hypertension, Uveitis, Systemic diseases like diabetes, or with ocular manifestations (collagen, skin, mucous membrane diseases), usage of topical medications which might affect the corneal conditions (esp. medications with preservatives), were excluded from the study. All subjects underwent specular microscopy at the time of presentation, and Central Corneal Thickness (µm) was recorded for each subject using TOPCON SP-1P Specular microscope.

Discussion
Pseudoexfoliation is a common systemic disorder with important ocular manifestations. It is the second most common identifiable cause of open-angle glaucoma worldwide, characterised by progressive accumulation and granular deposition of abnormal extracellular polymorphic fibrillar material in various intraocular and extracoroidal tissues. Flakes of exfoliative material maybe seen on the corneal endothelium, anterior lens capsule, ciliary processes and zonules, pupillary margin of the iris, and along the Schwalbe’s line.

Specular microscopy of corneal endothelium reveals significantly lower than normal cell density in eyes with PEX and changes in cell size and cell shape. Our study compared the central corneal thickness in patients with pseudoexfoliation using a specular microscope and compared them with healthy control eyes without pseudoexfoliation.

The mean age of patients in our study was 68.46±9.73 years in the PEX group and 67±10.81 years in the control group. The difference in the age group of the patients was not significant statistically (p-value 0.775). In a study conducted in Kashmir by Sofi IA et al. (2015), the mean age was 71.5±6.4 years. In our study, out of 100 participants, 53% were females, and 47% were males. In the PEX group, 54% of the participants were females, 46% were males, whereas in the control group, 52% were females, and 48% were males.

Our study did not show a predisposition towards any gender (p-value of 0.841). However, in a similar study conducted by Arvind H et al. (2003), females constituted 54.6% of subjects with PEX and males constituted 45.4% of them. Among subjects without PEX, 55.4% were females, and 44.6% were males.

Rashid W et al. (2015) reported a male to female ratio of 5.3:1 in cases of pseudoexfoliation. However, Sultana N et al. (2016), in their study on 30 patients of PEX, concluded no gender predisposition.

In this study, the mean Central Corneal Thickness obtained using a specular microscope in the PEX group was 587.34±27.16 µm, while in controls, the mean CCT was 505.09±26.36 µm. The results are consistent with the studies presented by Kitsos G et al. (2009), where they used an ultrasonic pachymeter to assess Central Corneal Thickness. Our study findings are also consistent with another study reported by Acar et al. (2010). Another study conducted by Yagci R et al. (2007) and Arnarsson A et al. (2007) also noticed that people with pseudoexfoliation had lower Central Corneal Thickness values. In contrast to this, a study conducted by Hepsen IF et al. (2007) and Arnarsson A et al. (2007) showed that cornea thickness in pseudoexfoliation cases is greater than in normal people. However, the study published by Zheng X et al. (2011) identified deposits of pseudoexfoliative material in the cornea. It showed that several keratocytes in the corneal stroma of pseudoexfoliative cases were lesser than in cases with pseudoexfoliation. They also concluded that this pseudoexfoliative material induces apoptosis of corneal stroma keratocytes and results in thinning of the cornea and greater susceptibility to elevated intraocular pressure.
Table 1 Comparison of central corneal thickness (µm) between PEX and controls.

| Central corneal thickness (µm) | PEX       | Controls | Total     | P value | Test performed |
|-------------------------------|-----------|----------|-----------|---------|----------------|
| Mean ± SD                     | 487.34 ± 27.16 | 505.09 ± 26.36 | 496.22 ± 28.14 | <.0001 | t test;4.69    |
| Median(25th-75th percentile)  | 489.5 (472-507.5) | 505.5 (488.5-525) | 498 (484.75-515) |        |                |
| Range                         | 409-531   | 436-573  | 409-573   |         |                |

n refers to the number of eyes evaluated.

Early detection of pseudoexfoliative glaucoma can aid to render appropriate treatment. Thus evaluation of endothelial cell density and central corneal thickness becomes an imperative pre-operative step in cases of pseudoexfoliation.

Conclusion
This study showed that pseudoexfoliative cases have significantly low Central Corneal Thickness, which may underestimate the IOP reading and overlook early Glaucomatous damage. Early detection of pseudoexfoliative glaucoma can aid to render appropriate treatment. Thus evaluation of central corneal thickness becomes an imperative pre-operative step in cases of pseudoexfoliation.

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Conflict of Interest
There are no conflicts of interest to declare by any of the authors of this study.

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