Original Article

Frequency and surgical difficulties associated with pseudoexfoliation syndrome among Indian rural population scheduled for cataract surgery: Hospital-based data

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Purpose: To study the frequency and intraoperative difficulties associated with pseudoexfoliation (PXF) syndrome at a tertiary eye care center in a rural central India. **Methods:** This study included patients scheduled for cataract surgery who were diagnosed with PXF syndrome. All patients underwent a complete ophthalmologic evaluation, including slit-lamp examination, tonometry, gonioscopy, and ophthalmoscopy before the surgery. Cataract surgeries were performed by a single surgeon who reported the intraoperative difficulties. **Results:** In total, 1022 phakic eyes of 1823 patients were evaluated, 226 of whom (22.1%) were diagnosed with PXF syndrome. Most eyes (n = 81, 35.8%) with PXF syndrome were ≥81 years old. Eighty-six eyes (38.1%) had bilateral involvement, whereas 70 (30.9%) had right or left eye involvement. Further, PXF material was distributed on the iris, pupil, and lens in 70 eyes (30.9%) and on the pupillary margin in 36 eyes (15.9%). The mean pupillary dilation was 5.1 (±1.4) mm in patients with PXF syndrome compared with 7.2 (±1.6) mm in those without it (P = 0.03). Grade VI cataract was observed in 93 eyes (41.2%) and hypermature cataract was the most commonly observed cataract stage. Twenty-one eyes (9.3%) had increased intraocular pressure. Intraoperative difficulties were encountered in 62 eyes (27.4%) with poor pupillary dilation being the most common problem (32 eyes, 14.2%), followed by zonular dehiscence (18 eyes, 8%). **Conclusion:** This hospital-based study showed that PXF syndrome is common in Indian rural population and that the intraoperative complication rate in these patients is high.

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Pseudoexfoliation (PXF) syndrome is commonly diagnosed by the appearance of a grayish white fibrillar material, also called PXF material, on the pupillary margin,[1] which may also appear on the lens surface, lens zonules, iris surface, corneal endothelium, trabecular meshwork, and anterior hyaloid surface. Its appearance on the surface of the intraocular lens and on the posterior capsule has also been reported.[2] It is a generalized disorder wherein the extracellular material is also observed in extraocular tissues.[3]

PXF syndrome is the most common cause of both open- and closed-angle glaucoma worldwide.[4–8] It is a clinically important syndrome as it is associated with zonular weakness as well as delayed dislocation of the crystalline and intraocular lens.[9–14] The prevalence of PXF syndrome reported in most studies varies (0.69–23%) with region and the study design,[6,15–26] including that reported in Indian population (0.69–3.8%).[6,15,22,23] Presently, there is only one study on prevalence of PXF in the rural population in central India by Jonas *et al*. This study has reported the prevalence of PXF as 0.95%.[15] However, intraoperative cataract surgical difficulties associated with PXF have not been studied in these patients in this region. In the present study, we aim to evaluate the frequency of this syndrome in patients visiting a tertiary eye care center in rural India for cataract surgery and its associated intraoperative difficulties to design strategies to reduce perioperative complications.

Methods

This prospective, cross-sectional, and observational study was conducted from January 2016 to May 2017 at a tertiary eye care center located in a rural area of central India. All patients provided written informed consent, and the study was conducted in accordance with the tenets of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of the hospital. Patients scheduled for cataract surgery and diagnosed with PXF syndrome during the study period were consecutively included. Patients with both pseudophakia and PXF syndrome, those <50 years old, and those with cataract

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due to uveitis, trauma, or systemic diseases were excluded. Demographic characteristics evaluated were age, sex, and place of residence (rural or urban). Patients having PXF were screened by the general physician for any systemic problem. Investigations like blood pressure, blood sugar, and electrocardiogram (patients with cardiovascular disease) were performed. Any systemic ailments were noted.

All patients underwent a visual acuity test using the Snellen chart as well as a complete ocular examination performed by a trained ophthalmologist (Dr. Rajesh Joshi) using a slit lamp before and after pupil dilation using a mydriatic (an ophthalmic solution containing 0.8% tropicamide and 5% phenylephrine hydrochloride). PXF syndrome was confirmed by the presence of fluffy white granular material on the lens surface, iris, or pupillary margin [Fig. 1a and b]. Intraocular pressure (IOP) was measured by applanation tonometry before and after pupil dilation, and gonioscopy was performed using a 3-mirror goniolens. Nuclear hardness was evaluated using a slit lamp after pupil dilation to determine the cataract and its grading based on the Lens Opacity Classification System (LOCS-III).[27]

Pupillary dilatation was measured under an operating microscope with a caliper. Any pupillary dilatation <5 mm was considered to be poor pupillary dilatation. Patients suspected of having glaucoma (due to the presence of optic nerve head abnormalities, history of glaucoma, and IOP >21 mm Hg) were screened for glaucoma according to the International Society for Geographical and Epidemiological Ophthalmology criteria.[28] A single surgeon (Rajesh Joshi) performed the cataract surgeries in all study patients by phacoemulsification technique through clear corneal 2.8 mm temporal incision (Galaxy Pro Phacoemulsifier, Appasamy Associates, Chennai, India). At the end of the surgical procedure surgeon reported the intraoperative difficulties. Patients with zonular dehiscence <90° were implanted with capsular tension ring (PMMA, 12–12.5 mm size, Polymer Technologies International, Vadodara, Gujarat, India).

The statistical analysis was performed using the EPI INFO 7.0 software (27 SEP 2017). Pearson's Chi-square test and *t*-test were used to test the significance of data at 95% confidence interval.

Results

In total, 1022 phakic eyes of 1823 patients were evaluated during the study period, 226 (eyes) of whom (22.1%) were diagnosed with PXF syndrome (frequency out of 1022 eyes). All patients were residents of the same district, with most patients living in rural areas (198/226 patients in rural areas; 28/226 patients in urban areas; $P = 0.02$). The mean age of the patient was 80.41 (±6.3) years in the PXF group and 68.55 (±6.4) years in the non-PXF group ($P = 0.04$). The age-wise distribution of patients with PXF syndrome is shown in Table 1. Most patients ($n = 81$, 35.8%) with PXF syndrome were ≥81 years old. Further, 119 patients were males (52.7%) and 107 were females (47.3%; male:female = 1:1.11; $P = 0.07$). Eighty-six eyes (38.1%) exhibited bilateral involvement and 70 eyes (30.9%) exhibited right or left eye involvement. Distribution of the PXF material in various ocular structures is shown in Table 2. The PXF material was distributed on the iris, pupil, and lens in 70 eyes (30.9%) and on the pupillary margin in 36 eyes (15.9%). Sixty eyes demonstrated equal distribution of the PXF material on the iris and lens (26.6%). Distribution of patients with PXF syndrome across different cataract grades is presented in Table 3. High-grade cataract was common in PXF syndrome. Ninety-three eyes (41.2%) diagnosed with PXF syndrome had Grade VI cataract. Morphologically, hypermature cataract was the most commonly observed, followed by mature cataract. Distribution of eyes with PXF syndrome across different cataract stages is depicted in Table 4.

Increased IOP was observed in 21 eyes (9.3%; odds ratio, 1:9.76; 95% confidence interval with confidence interval limit 7.76–11.76; $P = 0.05$). The mean IOP was 24 (±6) mm Hg. One eye (0.4%) had chronic angle-closure glaucoma, 18 eyes (8%) had open-angle glaucoma, and 2 (0.9%) had lens-induced glaucoma. Twelve eyes (5.3%) had lens subluxation.

The mean pupillary dilation was 5.1 (±1.4) mm in patients diagnosed with PXF syndrome compared with 7.2 (±1.6) mm in patients without it ($P = 0.03$). Pupillary dilation in patients

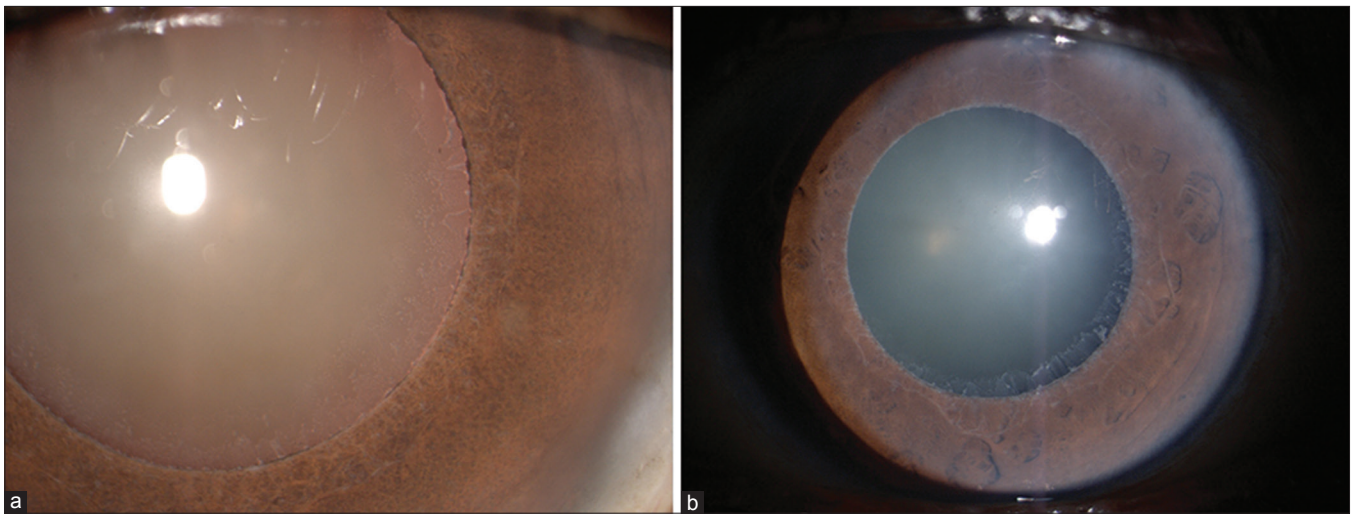

Figure 1: (a) Pseudoexfoliative material distributed on the lens, pupillary margin, and the iris. (b) Pseudoexfoliative material distributed along the zonules

with PXF material distributed on the pupillary margin, iris, and lens (4.2 ± 0.5 mm) was significantly less than that in patients with PFX material distributed on the lens or iris alone (5 ± 0.7 mm, $P = 0.05$). The mean preoperative visual acuity of patients with PXF syndrome was 0.098 ± 0.07.

A single surgeon performed the cataract surgeries in all patients and reported the intraoperative difficulties, which are presented in Table 5. Intraoperative difficulties were reported in 62 (27.4%) eyes, 32 of whom (14.2%) presented poor pupillary dilation, 12 of them (5.3%) needed iris retractors at the beginning of the surgery, and 5 eyes (2.2%) needed iris retractors during the nucleus removal and cortical aspiration stage. Iris capture with the phaco tip occurred in one of these patients (0.4%) during nucleus removal. Further, zonular dehiscence was the second most common complication that occurred in 18 eyes (8%), necessitating capsular tension ring placement to stabilize the zonular apparatus. Posterior capsular rupture occurred in three eyes (1.3%), for which anterior vitrectomy was performed, and the intraocular lens was placed over the anterior capsular rim. Five eyes (2.2%) were converted to small-incision cataract surgery from phacoemulsification because of extended capsulorhexis in two eyes and stony hard nucleus in three eyes. None of the patient had complete capsular bag removal instance.

Diabetes (n = 3, 1.3%), hypertension (n = 7, 3.1%), and ischemic heart disease (n = 3, 1.3%) were seen in patients with PXF. Psychiatric illness or hearing loss was not seen in any patient.

Discussion

The frequency of PXF syndrome in patients presenting scheduled for cataract surgery in the present study was 22.1%. To date, only two hospital-based studies on PXF syndrome (one in 1968 and another in 1984) have been conducted in India.[29,30] However, several population-based studies have been reported in India[6,15,22,23] and other countries.[8,16–21,24–26] We observed a wide variation in the prevalence of PXF syndrome reported in these studies. The possible reasons for this variation across studies are racial differences, environmental influences, and different screening strategies. The results of the present study support this variability. The frequency of PXF syndrome in our study (22.1%) was higher than that in most other hospital-based studies, namely 7.4% in Lamba and Giridhar,[30] 6% in the 50–60-year-age group in Govetto *et al*.,[31] 6.45% in Pakistan,[32] 19.53% in Yemen,[33] 11% in Turkey,[34] 3.5% in Riyadh,[35] 1.5%, Northern Nigeria,[36] 4.14% in Upper Egypt,[37] and 1.87% in India[29] and higher in study by Gelaw and Tibebu 35.82%[38] and Sufi *et al*. 26.32%.[39] The study by Lamba and Giridhar have stated prevalence of PXF on OPD basis, while the present study evaluated the frequency of PXF based on patients presenting for cataract surgery.

Sufi *et al*. evaluated the frequency of PXF in camp patients scheduled for cataract surgery in Kashmir, India. They have shown prevalence of PXF in the tune of 26.32%, that is higher than our study.[39] This could be due to high prevalence of cataract in the Kashmiri population and camp-based study in contrast to the present study which is hospital based.

In the population-based study conducted by Jonas *et al*. in rural areas of central India, the prevalence of PXF syndrome

Table 1: Age and number of eyes with pseudoexfoliation

Age (years)	Number of eyes with PXF n=226 (%)
51-60	10 (4.42)
61-70	60 (26.5)
71-80	75 (33.2)
81 and above	81 (35.8)

As the age increases eyes with PXF increases

Table 2: Distribution of pseudoexfoliation in ocular structures

Distribution of PXF in ocular structures	Number of eyes (%)
Pupillary margin	36 (15.9)
Iris	60 (26.6)
Lens	60 (26.6)
Iris, pupillary margin, and lens	70 (30.9)
Total	226

PXF was seen on the lens, pupillary margin, and lens in 70 patients (30.9%)

Table 3: Grade of cataract and number of eyes with pseudoexfoliation

Grade of the cataract	Number of eyes with PXF (%)
I	0
II	5 (2.21)
III	26 (11.5)
IV	43 (19.0)
V	59 (26.1)
VI	93 (41.2)
Total	226

Table 4: Type of cataract and number of eyes with pseudoexfoliation

Type of cataract	Number of eyes with PXF (%)
Hypermature	98 (43.4)
Mature	50 (22.1)
Nuclear	26 (11.5)
Cortical	25 (11.1)
Posterior subcapsular	20 (8.9)
Posterior polar	07 (3.1)
Total	226

Hypermature cataract was common

Table 5: Surgical difficulties in eyes with psudoexfoliation

Surgical difficulties	Number of eyes (%)
Poor pupillary dilatation	32 (14.2)
Pupillary catch	01 (0.4)
Rhexis extension	02 (0.9)
Zonular dehiscence	18 (8)
Posterior capsular rupture	03 (1.3)
Conversion to small incision cataract surgery	05 (2.2)
Total	62 (27.4)

Poor pupillary dilatation was common problem followed by zonular dehiscence

in individuals aged >30 years was 1.5% that is lower than that in our study.[15] A lower prevalence than that in our study was also found in various population-based studies from South India (3.8%),[6] Andhra Pradesh (0.69%),[22] Myanmar (3.4%),[20] rural South India (6%),[23] North China (5.8%),[40] Reykjavik (10.7%),[8] Finland (8.1%),[41] and Thessaloniki, Greece (11.9%).[17] A variable prevalence rate was noted in various population-based studies worldwide.

In our study, the frequency of PXF syndrome was 4.42% in 51–60-year-age group, which further increased to 35.8% in ≥81-year-age group. We included patients >50 years in our study as PXF and hard cataract is common after 50 years.[31] In a hospital-based study conducted by Govetto *et al*. on the prevalence of PXF syndrome among patients scheduled for cataract surgery, the syndrome was not observed in patients aged < 50 years.[31] In their study, two patients (6.1%) between 50 and 60 years old, 11 (7.3%) between 60 and 70 years old, 83 (19.1%) between 70 and 80 years old, and 149 (31.7%) >80 years old had PXF syndrome.[31] Similar observations were noted by Al-Shaer *et al*. in Yemen, wherein 10.1% patients between 41 and 50 years old and 28.8% >81 years old had the syndrome,[33] as well as in other studies from North Nigeria,[36] Riyadh (Saudi Arabia),[35] South India,[6] Turkey, and Ethiopia.[34,38]

In our study, gender-wise distribution of PXF syndrome showed no sex predominance, consistent with the results of a study from South India,[6] Hisayama (Japan),[25] Australia,[42] Beijing,[40] Saudi Arabia,[35] and Central India[15] as well as with those of studies by Lamba and Girdhar.[29,30] However, some reports have suggested male predominance[23,33,36] and a Reykjavik study has suggested female predominance.[8]

Bilateral involvement was observed in 86 eyes (38.1%), whereas right or left eye involvement was observed in 70 eyes (31%). In the study by Gelaw and Tibebu, 48 patients (33.3%) had unilateral involvement, whereas 96 patients (66.7%) had bilateral involvement.[38] Most studies have reported bilateral involvement more than unilateral involvement, as the unilateral disease is expected to progress to bilateral condition.[20,32,33,37] Another possible explanation is that Asian people have a high prevalence of bilateral PXF syndrome.[23]

In our study, the PXF material was distributed on the iris, pupil, and lens in 70 eyes (30.9%) and on the pupillary margin in 36 eyes (15.9%). This contrasts with the findings of the study by Idakwo *et al*. in which all patients had the PXF material on the peripheral zones of the lens and eight had on the pupillary margin.[36] Furthermore, Al- Saleh *et al*. reported the PXF material on the iris margin in 62.3% patients and on the pupillary margin in 0.11% patients.[35] This discrepancy could be due to late presentation of patients in our study.

Almost equal number of eyes had nuclear (n = 26, 11.5%) and cortical (n = 25, 11.1%) cataract, whereas hypermature cataract was observed in 98 eyes (43.4%). This is in disagreement with the findings of the study from South India,[22] Sri Lanka,[21] Ethiopia,[38] and North Nigeria.[36] High prevalence of hypermature cataract in our study could be because of late presentation of patients for cataract surgery due to common belief in rural India that surgery for cataract is required after it matures. Grade VI cataract based on LOCS III classification was observed in 93 eyes (41.3%). This result is in agreement with the results of Govetto *et al*.[31]

Numerous studies have shown a correlation between increased IOP and PXF syndrome.[6–8,15–21,22–26] However, one study from South India has reported no such correlation.[43] In our study, 21 eyes (9.3%) had glaucoma, which is considerably less compared with the number of patients in the study by Govetto *et al*. (16.7%),[31] Al-Saleh *et al*. (45%),[35] Yildirim *et al*. (26%),[34] Shazly *et al*. (30.3%),[37] Sood (34%),[29] as well as a South Indian study (16.7%),[6] a Turkish study (50%), and the Blue Mountains Eye Study (14%).[44,45]

Lamba and Giridhar (9%),[30] a North Nigerian study (4.4%),[36] and the Andhra Pradesh Eye Disease Study (4.2%)[22] reported a low incidence of glaucoma. Low incidence of glaucoma in our study could be due to the incidental finding of glaucoma in PXF syndrome, as suggested by Philip *et al*.[43]

The mean pupillary dilation was 5.1 (±1.4) mm in patients diagnosed with PXF syndrome compared with 7.2 (±1.6) mm in patients without it (P = 0.03). This is similar to the results of the study by Philip *et al*., wherein 96.7% eyes diagnosed with PXF syndrome had pupillary dilation of ≤6 mm.[43] Govetto *et al*. also reported that pupillary dilation is significantly less in PXF patients than in non-PXF patients.[31]

Pupillary dilation in patients with PXF material distributed on the pupillary margin, iris, and lens (4.2 ± 0.5 mm) was significantly less than that in patients with PXF material distributed on the lens or iris alone (5 ± 0.7 mm, P = 0.05). This could be due to the accumulation of PXF material on the iris and the pupillary sphincter, making pupils rigid and consequently unable to dilate.

Intraoperative difficulties in cataract surgery in patients with PXF syndrome have been reported in various studies.[9,46–49] However, Shastri and Vasavada have reported that intraoperative performance of cataract surgery in PXF eyes is comparable to that in non-PXF eyes.[50] In our study, intraoperative difficulties occurred in 62 eyes (27.4%) while performing cataract surgery by phacoemulsification. Naik and Gadewar have reported intraoperative complications in 26% (13/50) and 42% (21/50) patients during phacoemulsification and small-incision cataract surgery, respectively.[51] The common intraoperative complication observed in our study was zonular dehiscence (n = 18, 8%), consistent with the findings in several studies.[46–49,51] This complication is expected in patients with PXF syndrome, particularly in cases of high-grade cataract. Another complication is non-dilating pupil or decreased pupil dilation during the surgery. In our study, 12 eyes needed iris retractors at the beginning of the surgery and 5 during the nucleus removal and cortical aspiration stage. In one of these eyes, the iris got trapped into the phaco tip while chopping the nucleus. To prevent repeated entry of the iris in the phaco probe, iris retractors were applied at the two corners.

Five eyes (2.2%) were converted to small-incision cataract surgery from phacoemulsification due to extended capsulorhexis in two eyes and stony hard nucleus in three eyes.

Various studies have exhibited association between PXF and systemic diseases like hypertension, diabetes, myocardial infarction, angina, hearing loss, and psychiatric illness.[34,52–54] Systemic illnesses seen in the present study were

diabetes (n = 3, 1.3%), hypertension (n = 7, 3.1%), and ischemic heart disease (n = 3, 1.3%). The studied population being an old age population it was difficult to draw correlation between PXF and these diseases and was out of the scope of the study.

Conclusion

In this hospital-based study in rural India, the frequency of PXF in patients scheduled for cataract surgery was 22.1%. No significant difference was observed in its frequency between sexes. The occurrence of PXF syndrome was found to be associated with age and small pupils. However, no association was observed with glaucoma. None of the patients had associated systemic diseases. Zonular weakness and small pupils were common intraoperative difficulties. Thus, we suggest that capsular tension ring and iris retractors be kept alongside to tackle these problems and avoid suboptimal postoperative visual outcome.

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Conflicts of interest

There are no conflicts of interest.

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