CLINICAL STUDY OF INTRA OPERATIVE AND POST OPERATIVE COMPLICATIONS OF CATARACT SURGERY IN PATIENTS WITH PSEUDOEXFOLIATION

By

Dr. DISHITHA P. RATHOD

In partial fulfilment of the requirements for the award of the degree of

MASTER OF SURGERY

In

OPHTHALMOLOGY

Under the guidance of

Dr. VALLABHA K

M.S, D.O.M.S

PROFESSOR AND H.O.D

DEPARTMENT OF OPHTHALMOLOGY
B. L. D. E. UNIVERSITY'S SHRI B. M. PATIL MEDICAL COLLEGE,
HOSPITAL & RESEARCH CENTRE
VIJAYAPUR 586103

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Date:

Place: Vijayapur **Dr. DISHITHA P. RATHOD**

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Date:

Place: Vijayapur

Dr. VALLABHA KM.S, D.O.M.S

Professor,
Department of Ophthalmology
BLDEU'S Shri B.M Patil
Medical College Hospital and
Research centre, Vijayapur.

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SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPUR

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Date:

Place: Vijayapur

Dr. VALLABHA K.

M. S., D.O.M.S.(Ophthalmology)
Professor,
BLDEU's Shri B.M. Patil
Medical College, Hospital &
Research Centre, Vijayapur.

B.L.D.E UNIVERSITY'S
SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPUR

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Date:

Place: Vijayapur

Dr. S. P. GUGGARIGOUDAR

M.S. (ENT)
BLDEU's Shri B.M. Patil
Medical College, Hospital &
Research Centre, Vijayapur.

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ABSTRACT

INTRODUCTION

Pseudoexfoliation syndrome(PEX) is defined as a clinically important systemic condition characterized by the pathological production and accumulation of an abnormal fibrillary extracellular material. PXF is a known risk factor for development of cataracts. Also, deposition of pseudoexfoliative material on the zonular fibers weakens it leading to phacodonesis, subluxation and dislocation of lens. Cataract surgery in eye with pseudoexfoliation has higher incidence of operative complications like posterior capsular rupture, zonular dialysis, vitreous loss and intra ocular bleeding. Due to the high frequency of complications associated with cataract surgery in such patients, possible pre-operative and intra-operative measures to avoid or minimize these complications include an increased awareness of pseudoexfoliation syndrome, a careful slit lamp examination after full pupillary dilatation, adequate control of intra-ocular pressure pre-operatively, avoidance of iris manipulation, adequate pupillary dilatation, use of heparin coated intra-ocular lenses and judicious use of steroids post-operatively.

AIMS AND OBJECTIVE

The aim is to study the intra operative and post operative complications of pseudoexfoliation in manual small incision cataract surgery and document the complications of PEX in cataract surgery so that these complications can be prevented.

MATERIAL AND METHODS

This was a prospective longitudinal study conducted at BLDEU's shri B. M. Patil Medical College Hospital and Research Centre, Vijayapur from Oct 2015 to

April 2017 and included 60 patients aged 45 years and above of either sex diagnosed with PXF and cataract. Preoperative evaluation with history, systemic & ocular examination with Snellen's chart, Slitlamp, Gonioscopy, Tonometry & dilated fundus examination was done and for complications patients were noted intraoperative, Postop day 1, postop day 8, postop 1 month and 3 months.

RESULTS

A total of 60 eyes of 60 patients were diagnosed with PXF, showing a prevalence rate of 3.95%. Incidence increases with age, 76.7% were Bilateral, 78.3% had moderate PEX, 40% had insufficient mydrasis, 90% had IOP range 11-20mmHg, 10% had <10mmHg IOP, 81.7% had open angles, 71.7% had nuclear cataract, 28.3% had mature cataract, 1.7% had subluxation of lens and 5% had phacodonesis. Intraoperative 73.3% surgeries were uneventful, 10% had Zonular dehiscence, 6.7% had Posterior capsular rupture, 3.3% had vitreous loss, 1 patient was left aphakic, in 1 patient ACIOL was put. Postoperatively day-1 corneal edema in 31.7% patients & uveitis in 36.7%. At the end of 3 months, 1 patient had endothelial decompensation & 30% of patients had irregular pupils mostly due to spincterotomies and 20% of patients had IOL decenteration.

CONCLUSION

Presence of PXF is a risk factor and challenge to the cataract surgery. Its preoperative work up with sufficient measures during surgery can cut down the incidence of complications & the best results can be achieved.

KEY WORDS:

Pseudoexfoliation syndrome; pseudoexfoliation; mydrasis; zonular dehiscence; posterior capsular rent; IOL decentration.

LIST OF ABBREVATIONS

PXF / PEX	Pseudoexfoliation
PXS	Pseudoexfoliation Syndrome
PEXG	Pseudoexfoliation Glaucoma
RE	Right eye
LE	Left eye
IOP	Intraocular Pressure
AC	Anterior Chamber
SIMC	Senile immature cataract
SMC	Senile Mature cataract
NS	Nuclear sclerosis
SD	Standard deviation
U/E	Uneventful
SK	Striate Keratopathy
F/C	Flare / cells
Irr	Irregular
CTR	Capsular Tension Ring
CCC	Continuous Curvilinear Capsulorrhexis
POD	Post operative day

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INTRODUCTION

"Pseudoexfoliation syndrome (PEX) is defined as a clinically important systemic condition characterized by the pathological production and accumulation of an abnormal fibrillary extracellular material on the anterior lens capsule, zonules, ciliary body, pupillary margins of the iris, corneal endothelium, anterior vitreous and trabecular meshwork, and extra-ocular tissues which includes skin, lung, myocardium, liver, gall bladder, kidney, and meninges"[1]. PXS and PXG have been associated with mutations in LOXL1 gene (15q24) which codes for elastic fiber components of extracellular matrix.[1]

The exact aetio-pathogenesis of this condition and chemical composition of the material still remains under speculation.

Renewed interest in this long known entity results from better awareness of the spectrum of intra-ocular risks not only for open angle glaucoma but also in association with/or intra-ocular surgery, especially cataract extraction.

In the eye, Pseudoexfoliation syndrome is characterized clinically by small white deposits of material in the anterior segment, most commonly in the pupillary border and the anterior Lens capsule. The most consistent diagnostic feature is three distinct zones of pseudoexfoliation material seen on the lens capsule after full dilatation.

- A translucent, central disc with occasional curled edges.
- Middle clear zone corresponding to probable contact with the moving iris.
- Peripheral granular zone, which may have radial striations. (Central zone is absent in 20% or more cases, but peripheral defect is a consistent finding in all

cases. Therefore, pupillary dilatation is a must before lens changes can be seen.).[1,2,3]

Additional clinical signs that help in early diagnosis are loss of pigment from peri-pupillary area producing trans illumination defects, insufficient mydriasis, pigment dispersion into anterior chamber after mydriasis, increased pigmentation in trabecular meshwork (uneven distribution) and Schwalbe's line(Sampaolesi line). In eye marked asymmetry of trabecular meshwork pigmentation, glaucoma is more common in more pigmented eye. The existence of circular or segmental posterior synechiae without any other cause and hemorrhage in the iris stroma after mydriasis are also suggestive of pseudoexfoliation syndrome.[4] The presence of secondary open angle glaucoma is known as glaucoma capsulare. The glaucoma has more serious clinical course and worse prognosis than primary open angle glaucoma, often not responding to medical therapy and requiring early surgical intervention. Angle closure glaucoma may also be seen due to pupillary block by forward displaced lens. The corneal epithelium shows decreased cell count and pleomorphism leading to early corneal decompensation at moderate rises in intraocular pressure and after cataract surgery.[5]

PXF is a known risk factor for development of cataracts. Also, deposition of pseudoexfoliative material on the zonular fibers weakens it leading to phacodonesis, subluxation and dislocation of lens. Cataract surgery in eye with pseudoexfoliation has higher incidence of operative complications like posterior capsular rupture, zonular dialysis, vitreous loss and intra ocular bleeding.[5]

Since, virtually all structures of the eye show involvement of pseudoexfoliation material, patients have a significantly greater risk for a variety of intra operative and post-operative complications during cataract surgery. Poor

mydriasis, pigment dispersion, combined with phacodonesis, subluxation/dislocation of lens and zonular dialysis predisposes to capsular rupture and vitreous loss and intraocular bleeding. Breakdown of blood-aqueous barrier leads to transient elevations of intraocular pressure and fibrinoid uveitis after surgery. Late complications include posterior capsular opacification, secondary cataract, and decentration of intra-ocular lens and decompensation of corneal endothelium.

Due to the high frequency of complications associated with cataract surgery in such patients, possible pre-operative and intra-operative measures to avoid or minimize these complications include an increased awareness of pseudoexfoliation syndrome, a careful slit lamp examination after full pupillary dilatation, adequate control of intra-ocular pressure pre-operatively, avoidance of iris manipulation, adequate pupillary dilatation, use of heparin coated intra-ocular lenses and judicious use of steroids post-operatively.

The public health implications of the association of PXF with blindness related to cataract and glaucoma, frequently goes undiagnosed leading to unexpected problems during surgery. Identification of the prevalence of PXF and understanding the outcomes of surgical management in these patients scheduled for cataract surgery will help us in better managent and better visual rehabilitation.

Furthermore, there is an increase in prevalence of PEX as the mean age of the general population increase, yet the clinical implications of the systemic manifestations of this disorder remain unknown.

Much remains to be learned about the PXF material not only at the basic levels of production and biochemical nature but also with regard to its genetics, epidemiology and treatment. In view of the multitude of clinical complications, we

need to be aware of the risks and specifically look for clinical signs of this entity. PXS may appear as harmless anomaly of the anterior segment but its potentially catastrophic nature should not be underestimated.[1,4]

AIM AND OBJECTIVE OF THE STUDY

AIM: The aim is to study the intra operative and post operative complications of pseudoexfoliation in manual small incision cataract surgery.

OBJECTIVE: The objective is to document the complications of pseudoexfoliation in cataract surgery so that these complications can be prevented.

- Preoperative complications
    1. Poor mydriasis
    2. Pigment dispersion post dilatation.
    3. PXF grading
    4. Lens changes
    5. Anterior chamber depth
- Intraoperative Complication
    1. Pupil management measures.
    2. Zonular dialysis
    3. IOL placement
    4. Posterior capsular tear
    5. Vitreous loss
- Postoperative complications
    1. Fibrinoid uveitis
    2. Corneal endothelial decompensation
    3. Posterior capsular opacity
    4. Cystoid Macular Oedema

REVIEW OF LITERATURE

- Lindberg was the first person who described PXF for the first time in a Finnish population, in 1917. He was of the opinion that this material was created as a result of earlier inflammation.[6]
- In 1918, a full description of PXF was given by a Swiss Ophthalmologist Alfred Vogt. He described PXF as a film on the anterior lens capsule due to remnants of pupillary membrane.[7]
- In 1925, the histological studies done by Davok-Theobald differentiated between true exfoliation seen in glass blowers and senile exfoliation. Senile exfoliation was then termed as pseudoexfoliation'. He also have full description as 'Exfoliation of the lens capsule' and its deposition on lens capsule, iris, back of the cornea and its association with 'glaucoma capsulare' was made.[8]
- In 1973, W.E. Gillies reported that patients who underwent ICCE caused the PXF material to diminish and regress and cataract extraction may be helpful in patients with cataract, PXF, and a rise in intra ocular pressure.[9]
- In a study done in 1993, postoperative results and complications in 136 eyes with PXS were compared to 744 eyes without PXS in a consecutive study. The patients were followed for 4 months postoperatively. Excluding cases with glaucoma, 81.4% of the PXF eyes and 83.0% of the eyes without PXF achieved a corrected visual acuity of 5/8.5 or better. IOL malposition was rare in both groups (1.5% in the PXF group and 1.6% in the group without PXF). IOP elevation the first day postoperatively occurred most often in the PXF eyes. In the PXF eyes, postoperative iritis and cellular precipitates were demonstrated in 16.2% and 11.0%, respectively, compared to 3.8% and 3.2%

in the eyes without PXF ($p < 0.001$). The frequency of an inflammatory reaction was highly correlated to small pupil size during operation in both groups.[10]

- In 2003, study by Aravind H, Raju B, Paul B G, Baskaran M, Ramesh S V, George R J, et al showed among the 2850 subjects 108 subjects had PXS (3.8%). There was a significant increase in prevalence with age but no sex predilection. The condition was unilateral in 53 cases (49.1%) and bilateral in 55 cases (50.9%). 18 cases with PXF (16.7%) and high intraocular pressure (>21 mmHg), 16 cases (14.8%) had occludable angles, and 14 cases (13%)PXG. There was a significantly higher prevalence of cataract among people with PXF compared to those without PXF (P=0.014).[11]
- In 2005, Ravi Thomas, Praveen Kumar Nirmalan and Sannapaneni Krishnaiah conducted a study of PXF in Southern India. It showed subjects with PXF had a significantly higher prevalence of blindness than did those without PXF. They also found a strong association of PXF with age and any type of cataract in particular nuclear cataract and mandates complete clinical examination including slit lamp biomicroscopy and dilated examination to detect early pseudoexfoliation.[12]
- In 2011, a study by Tarek A Shazly, Abdelsattar N Farrag, Asmaa Kamel and Ashraf K Al-Hussaini reported that prevalence of PXF among upper Egyptian individuals aged 40 years or older to be 4.14%. This rate is similar to other studies conducted in South India, The Chennai studies, and Blue mountain eye study. It also showed PXF had increased association with cataract (65%), glaucoma (30.3%) and hearing loss (8.1%).[13]

- In 2017, Uri Avi MD, Ben Ner, Nardine Sharif, Zvi Gur MD et al published a review article enumerating the various systemic associations of PXF with systemic diseases such as increased vascular risk, risk of dementia and inflammatory state. The exfoliated material detected on slit lamp, has also been found in skin, heart, lungs, liver and kidney.[14]
- In 2017, Lee SY, Kim S, Kim JH et al reported a prevalence of 1% among the residents between 50 - 59 years of age and a prevalence of 23.3% among those over 80 years of age. There was no significant difference in the prevalence between men and women in all age groups. The age-standardized prevalence rate of PXS was 10.4% (95% CI, 8.0%-12.8%), with a rate of 9.4% (95% CI, 5.8%-13.1%) in men and 14.9% (95% CI, 11.3%-18.4%) in women. PXS showed no significant association with smoking, outdoor activity, and occupation, except alcohol consumption. PXS, however, did show significant decrease in endothelial cell density. Pure tone audiometry test of PXS group revealed statistically significant decrease in 1, 2 kHz.[15]
- In 2017, Fallah Tafto MR, Abdollah Beiki H, Mohammadi SF et al studied the anterior chamber depth change following cataract surgery in patients with pseudoexfoliation. A total of 26 eyes were studied. Pseudophakic anterior chamber depth (PP-ACD) was deepened (mean change: 0.08 mm) and a concurrent hyperopic shift (0.3 D) was observed postoperatively between month 1 and month 6 (P values ≤ 0.002). PP-ACD and postoperative refraction changes were correlated with age and AL (P values < 0.025), respectively. Increased hyperopic shift and PP-ACD deepening in eyes with posterior capsule opacification (PCO) was noted postoperatively at six months, but the

difference was not statistically significant (*P* values = 0.15 and 0.2, respectively).[16]

- Naik AU and Gadewar SB, in 2017, studied the visual outcomes of a total of 200 eyes of 100 patients conforming to pre-defined criteria were conveniently sampled and allotted to two groups of 50 patients each. First group underwent PHACO and second underwent SICS. No statistically significant differences were observed between PHACO and SICS groups with regards to intra-operative complications {overall n=13 in PHACO versus n=21 in SICS, p=0.13}.[17]
- In 2017, the Malaysian Cataract Surgery Registry enlisted pseudoexfoliation (95% CI 1.02 to 1.82; OR 1.36) as a major risk factor for posterior capsular rent after a retrospective study conducted by Salowi MA, Chew FLM, Adnan TH, Ismail M and GOH PP.[18]

EPIDEMIOLOGY

The prevalence of PXF increases dramatically with age and varies considerably among populations worldwide. PXS has now been described as the most common identifiable cause of open angle glaucoma worldwide.[1,2,3]

The reported global prevalence rate of PXF in different populations shows extensive variations (from 0% to 38%) – 0% in Eskimos,[19] 1.6% in a south eastern US population, 1.8% in the Framingham Eye Study,[20] 5-25% in the Scandinavian countries,[19] and 38% in Navajo Indians. These prevalence rates possibly reflect true variations arising from racial, genetic, and / or geographical differences. It has been reported to be the most common in patients of Scandinavian heritage.

The prevalence of PEX syndrome in India has been studied over the last few years. Prevalance of PXS in India and south India is reported to be 7.4% and 3.4% respectively. The first, by Sood and Ratnaraj in 1968, reported 1.87% prevalence in patients aged 45 years or above with a 34% prevalence of glaucoma in patients with PEX.[21] In 1984, the second report on the subject by Lamba and Giridhar reported a 7.4% prevalence of PEX, 9% of whom had glaucoma.[22] Recent study by Shankar Nethralaya, found a 3.8% prevalence of PEX syndrome in the rural population of South India aged 40 years and above.[11]

Geographic distribution patterns may be explained by regional gene pools, environmental influence, ultraviolet light exposure and examination techniques. No clear relation between PXS prevalence and gender is found. PXS more common is older age group, most cases occurring late 60s and 70s. The condition can be unilateral or bilateral, over 50% of unilateral cases become bilateral over a period of 20 years.

In a given population, the actual prevalence of Pseudoexfoliation Syndrome is probably twice that which is visible on clinical examination. Many cases go undetected because of failure to dilate the pupil or to examine the lens with the slit lamp after dilatation of the pupil.

GENETICS

Genetic and environmental factors are known to play an integral role in the pathogenesis of PXS.[23] Genetic etiology of PXS and glaucoma in population of Iceland and Sweden has been recently studied.

A hereditary transmission of Pseudoexfoliation Syndrome is not yet clarified. Tarkkanen[24] (1962) suggested the presence of a gene bearing 3 characteristics, an abnormality of the drainage channels of the aqueous, Pseudoexfoliation and degeneration of the pigment epithelium of the iris. Variations in the expressivity of this gene would explain why the 3 events are sometimes found together and why sometimes only 1 or 2 is present.

Kelvin Y.C. Lee et al[25] studied about XFS/XFG associations with polymorphisms with R141L, G153D and intronic located in the 1st exon of the lysyl oxidase like 1 gene (LOXL1) on Chromosome 15q 21.[1] LOXL1 is one of many enzymes essential for the formation of elastin fibers. It plays a role in modifying tropoelastin, the basic building block of elastin, and catalyzes the process for monomers to cross-link and form elastin. Mice lacking LOXL1 protein have diffuse elastic tissue changes associated with tropoelastin accumulation, including pelvic organ prolapse, enlarged airspaces of the lung, loose skin, and vascular abnormalities.[1,23] Asian populations including Indians reported associations with LOXL1 and XFS.

R.R. Allinghan et al[26] (2001) investigated 6 islandic families each of which had at least 1 member affected by Pseudoexfoliation Syndrome they concluded that Ps Pseudoexfoliation Syndrome is an inherited condition with transmission to the 2nd generation through an affected mother.

There are no unequivocal findings regarding the role of environmental factors in the development of Pseudoexfoliation Syndrome.

HISTOPATHOLOGY

In the usual case of exfoliation syndrome, the thin layer of zonular lamella, rubbed upon by the iris and pupil borders is rubbed off and often is stripped up peripherally to form a partially free membrane. This is considered as capsular exfoliation. The rubbed-off portion and the fibrillar material deposited on it, along with pigment granules from abraded pigment epithelial cells, are set free into the aqueous and deposited elsewhere in the posterior and anterior chamber by aqueous thermal currents; accounting for deposits on the cornea, anterior iris, trabecular meshwork, zonules, and even the ciliary body surface epithelium.[1]

Considering the source of the fibrillar material, there are only three parts of the eye that are reasonable possibilities:

1. The lens epithelium and capsule;
2. The iris pigment epithelium; and
3. The ciliary epithelium.

The ciliary epithelium is undoubtedly a source of aqueous-carried material, but it certainly does not appear to be as directly related to the material on the anterior lens capsule as the iris pigmented epithelium.[27]

Davenger and Pedersen described the histology of PXF material as consisting of fibrils and ground substance[28] the main constituent of the fibrils being mucopolysaccharides.

According to the theory of Bertelsen and associates[29] the epithelial cells in the nterior periphery of the lens are stimulated by pathophysiologic factors to form new incomplete basement membranes and a substance which, at least when fixed, appears as fibrils. These fibrils pass through the amorphous layer of the capsule, enter the fibrillar layer of the capsule as clefts containing granules and then become fibrillar again on reaching the lens surface where bush-shaped excrescences appear. Thus, fibrillar material within the eye appears to come from both lens epithelial and iris pigment epithelial-ciliary epithelial sources, as if both were part of a diffuse basement membrane disease, although they probably remain separate anatomically. The portion from the lens epithelium remains within the amorphous and fibrillar layers of the capsule and does not appear to contribute to the substance on its surface, while the iris material is transferred directly to the capsule only in areas of contiguity. Smaller amounts may be deposited elsewhere from material carried in the aqueous currents.

Light microscopy indicates the presence of true zonular lamellar exfoliation plus deposition of pink staining material on its surface. The smaller fibrils (15 nm) cover the entire lens surface; the larger fibrils (25-37 nm) are usually present in the mid peripheral zone. The smaller fibrils are elements of the pericapsular membrane (zonular lamella), the part of the capsule that is truly exfoliated, and that the others are basement membrane like material elaborated by diseased, but stimulated, iris pigment epithelial cells which are deposited on the zonular lamellar surface. Participation of the ciliary epithelium in the elaboration of the material is certain, but it does not

appear to be related to the material on the anterior lens capsule by direct contact, as in the case of the iris pigment epithelium.[30]

By electron microscopy, the capsular exfoliative fibrils appear to be basement membrane material. The probability exists that the exfoliation syndrome is a basement membrane disease in which synthesis of the substance is stimulated by the aging process.[27]

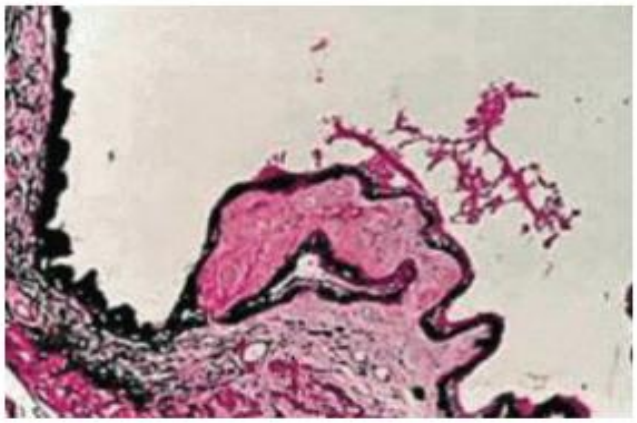


Fig. 1 : Light micrograph of PAS positive exfoliative material overlying ciliary body process

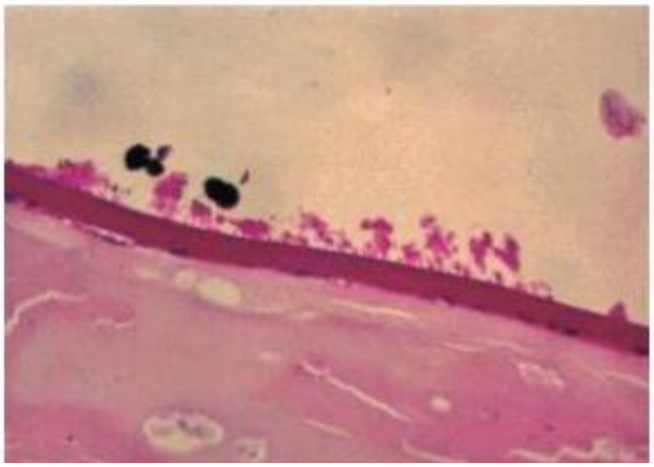


Fig. 2 : Light micrograph of PAS positive exfoliative fibres on the len capsule

CLINICAL FEATURES

1. OCULAR MANIFESTATIONS (1), (31), (32), (33), (34), (35), (36).

   a) LENS AND ZONULES

      Deposits of white flaky material on the anterior lens surface are the most consistent and important diagnostic of Pseudoexfoliation Syndrome. The classic pattern consists of 3 distinct zones that become visible when the pupil is fully dilated – a relatively homogeneous central disk corresponding roughly to the diameter of the pupil, a granular often layered peripheral zone and a clear area separating the two. The central zone is homogeneous white sheet lying on the anterior pole of the lens capsule. Its diameter varies between 1.5 – 3 mm and it is usually slightly smaller than the physiological pupil. The edges of the disk are often rolled equatorially. The central disk is absent in 20 – 60% of cases. It is often initially overlooked but with careful examination after dilatation, a subtle area of Pseudoexfoliation material may be noted especially when compared to the adjacent intermediate clear zone. It may be granular in the periphery and frosty white centrally and radial striations are often seen. It may be layered. Axially it is bounded partly by curled edges and partly by tongue shaped projections. Equatorially it extends as granular tongue shaped projections which merge into the normal capsule before reaching the anterior zone of insertion of the zonular fibres. The peripheral band may be situated close to the equator in some eyes and more axially in others. The granularity of the peripheral layers is consistent with undisturbed accumulation of Pseudoexfoliation material.

Whereas the classical picture of Pseudoexfoliation Syndrome has often been described, the early stages have not been well defined. A precursor of Pseudoexfoliation material is thought to be initially deposited diffusely on the lens surface. A homogeneous "ground glass" or "matte" appearance of the lens surface in one eye compared to the other may represent a very early (pre-capsular) stage. In a perhaps slightly later (pre-granular) stage, there may be very faint radiant non-granular striae on middle third of the anterior capsule behind the iris. Ultra structurally, the pre-capsular layer at this stage consists of micro-fibrils, but not mature exfoliation fibrils. To visualize the earlier stages at the slit lamp, placing the slit beam at 45˚ to the axis of observation reducing the light source and focusing temporarily 2 – 3 mm from the centre of the lens may help to highlight the subtle deposits on the lens surface. The intermediate clear zone is created by rubbing of the iris over the surface of the lens during papillary movement. As the pre-capsular layer becomes thicker the iris sphincter begins to rub against it during normal pupillary movement. Faint clefts begin to form where Pseudoexfoliation material is rubbed away in what will eventually become the clear zone. With time, these clefts increase in size and begin to become confluent. Eventually only small bridges may remain as an indication of the previous layer of Pseudoexfoliation material in the intermediate zone. In some patients the central disk may become thick enough to peel away in sheets from the lens, as may the peripheral zone, giving rise to appearance of True Exfoliation Syndrome. Chronic pupillary dilatation also permits undisturbed accumulation of Pseudoexfoliation material.

Clinical classification of various stages is based mainly but not only on the findings of the anterior lens capsule.[1]

- SUSPECT PSEUDOEXFOLIATION SYNDROME:
  - Early Pseudoexfoliation Syndrome (Electron Microscopy): Pre-capsular layer.
  - Masked/Suspected Pseudoexfoliation Syndrome: Posterior synechiae without any obvious cause.
- DEFINITE PSEUDOEXFOLIATION SYNDROME:
  - Mini-Pseudoexfoliation Syndrome: Focal defects in pre-capsular layer especially supero-nasally.
  - Classic Pseudoexfoliation Syndrome: Late stage.

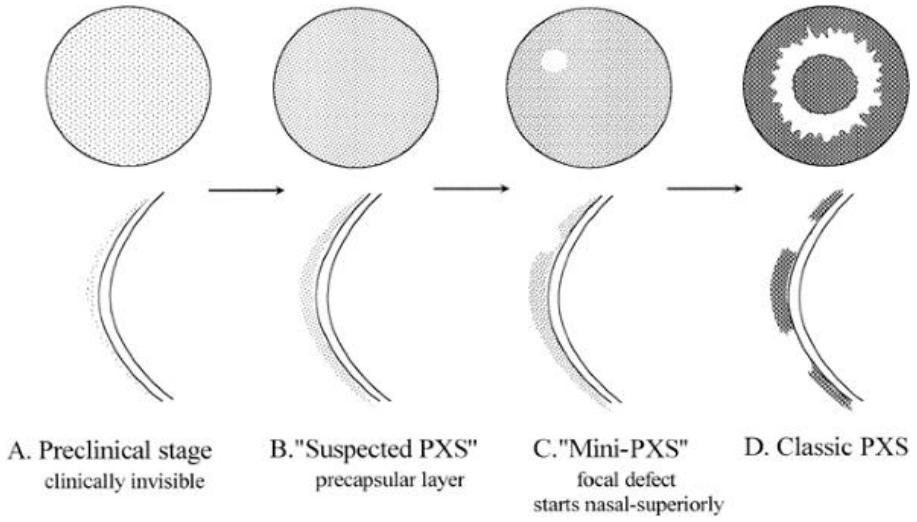


Fig 3: Stages of PXF

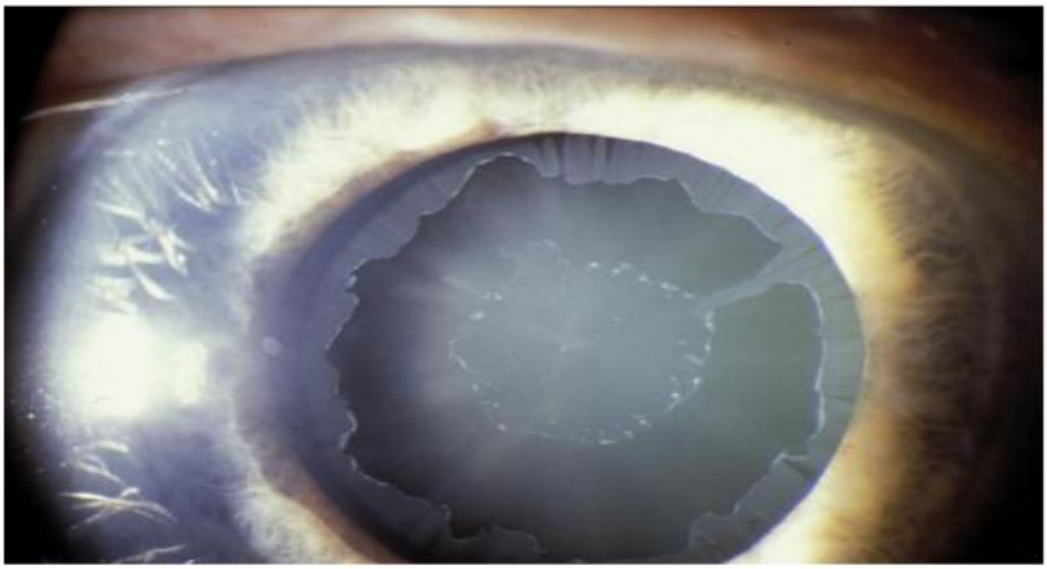


Fig. 4 : Pseudoexfoliation material deposited on the anterior lens capsule with three distinct zones

Phacodonesis is common but not always associated with iridodonesis, perhaps attributable to increased iris rigidity.

Spontaneous subluxation and dislocation of lens can occur; the denser the Pseudoexfoliation material, the more likely there is to be phacodonesis. Lens dislocation is more common inferiorly.

The Zonular fibrils coated with varying amounts of Pseudoexfoliation material become stretched and eventually break. Break does not occur at the attachment to the zonular lamellae but at their ciliary attachments. The broken fibers may be seen waving gently in the aqueous. Subsequently the fibers become shorter and thicker and finally appearing as irregular clumps on the lens surface. The fibers that break 1st are those behind the equator and those just anterior to the equator remain intact the longest.

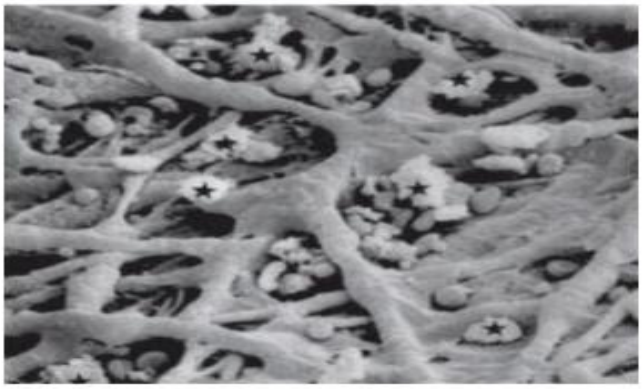


Fig. 5 : Scanning electron micrograph of the inner surface of the trabecular meshwork shows exfoliation deposits (stars) in the uveal pores

b) IRIS AND PUPIL

Next to lens, Pseudoexfoliation material is most prominent at the pupillary border. It may be extensive or minimal. The iris is more rigid because of the material. Pigment loss from the iris sphincter region and its deposition on the anterior chamber structures is the hallmark of Pseudoexfoliation Syndrome. The material on the lens causes rupture of iris pigment epithelial cells at the ruff and sphincter region with concomitant dispersion of pigment into anterior chamber. Loss of iris pigment and its deposition throughout the anterior segment are reflected in iris sphincter region transillumination, loss of pupillary ruff, increased trabecular pigmentation and pigment deposition on the iris surface. Extensive depigmentation may be noted over the entire sphincter region, which appears as a diffuse starry sky pattern on transillumination or moth eaten appearance.

Pseudoexfoliation Syndrome predisposes to formation of synechiae between iris pigment epithelium and the anterior lens capsule. Posterior

synechiae are more prone to form between the iris and intra-ocular lens post operatively. Iris blood vessel abnormalities include Narrow or obliterate lumen, with marked alteration of iris vasculature, vessel dropout with collateral formation and iris hypo perfusion leading to patchy iris neo-vascularization.[31]

Inflammation after cataract extraction is more common and a transient fibrinoid reaction attributed to breakdown of Blood-aqueous barrier may occur.[32]

Intra-stromal hemorrhage after mydriasis is indicative of vascular damage. Atrophic changes of sphincter and dilator muscle tissues, possibly because of hypoxia, and apparent impairment of muscle cells by Pseudoexfoliation material may contribute to poor apillary dilatation. Reduction of stromal elasticity by accumulating Pseudoexfoliation material may also play a role in poor mydriasis. Dispersion of melanin granules after diagnostic mydriasis or surgery can be so pronounced that heterochromia iridium may be produced. The mechanism of melanin liberation is related to degenerative changes and cell membrane ruptures of the posterior pigmented epithelial cells due to extra-cellular Pseudoexfoliation material. Marked intra-ocular pressure rise after mydriasis correlates with the amount of the pigment liberated.

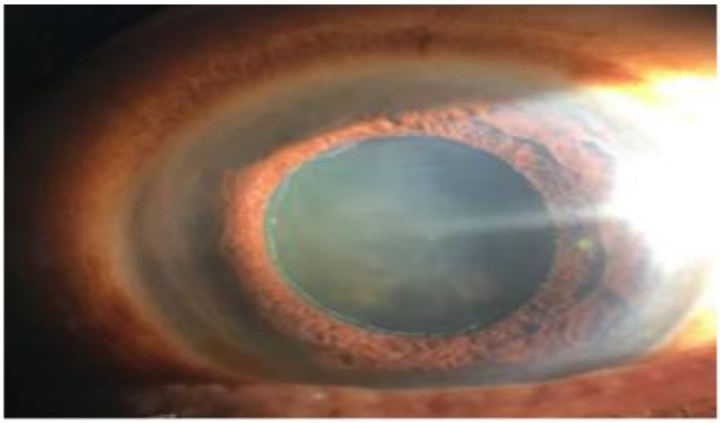


Fig. 6 : Insufficient mydriasis

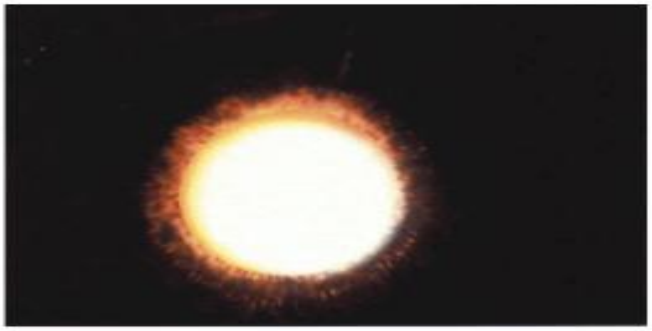


Fig. 7 : Peripupillary pigment epithelium of the iris. Producing transillumination defects in the sphincter

c) CILLIARY BODY

The cilliary processes were examined clinically by Mizuno and Muroi (33) with special type of Gonioscopy lens, almost all eyes with exfoliation showed accumulation of material on the zonules and ciliary body.

d) GLAUCOMA AND PSEUDOEXFOLIATION SYNDROME (34) (35):

While the existence of association between Pseudoexfoliation Syndrome and Open Angle Glaucoma has been well known, the

mechanisms are still not clarified. There is an increase in the aqueous outflow resistance probably due to trabecular cell dysfunction, blockage of meshwork by Pseudoexfoliation Syndrome liberated pigment and concomitant primary open angle glaucoma.

In patients with pseudoexfoliation syndrome, 20% have glaucoma and increased IOP at the time of diagnosis. Patients who have pseudoexfoliation syndrome but not glaucoma should be considered vulnerable to glaucoma, because 15% of such patients develop increased IOP with in 10years. This underscores the need for careful follow-up in patients who have pseudoexfoliation syndrome. Pseudoexfoliation syndrome accounts for 15-20% of cases of open angle glaucoma.

Glaucoma in Pseudoexfoliation Syndrome has a more serious clinical course and worse prognosis than Primary Open Angle Glaucoma. There is a significantly higher frequency and severity of optic nerve damage at the time of diagnosis, worse visual field damage, and poorer response to medications, more severe clinical course and more frequent necessity of surgical interventions. In normotensive eyes, with Pseudoexfoliation Syndrome the mean Intra-ocular pressure is higher than in eyes without Pseudoexfoliation Syndrome. In patients with elevated Intra-ocular pressure, mean intra-ocular pressure is higher at the time of diagnosis in patients with Pseudoexfoliation Syndrome, than in those with primary open angle glaucoma. Glaucomatous damage at the time of diagnosis is more severe and progression is also more rapid in eyes with Pseudoexfoliative glaucoma.

A number of characteristics predispose to development of angle closure glaucoma in eyes with Pseudoexfoliation Syndrome. Pupillary block may be caused by combination of posterior synechiae, increased iris thickness or rigidity or anterior lens movement secondary to zonular weakness or dialysis.

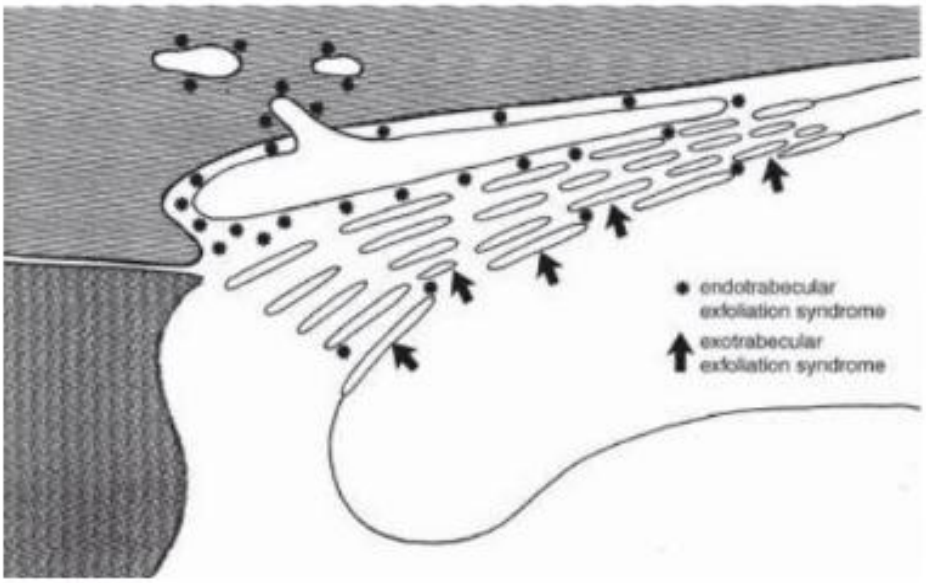


Fig. 8 : Schematic of the trabecular meshwork shows localization of PXF deposits of presumed endotrabecular and exotrabecular origin

e) ANGLE CHARACTERISTICS[34] :

As the iris is more rigid than normal, aqueous presence in the posterior chamber causes it to bulge at the weakest point which is the iris route. Thereby, the localized iris bombe near the iris route narrows the angle, giving a pseudo-plateau iris configuration on gonioscopy and leads to chronic angle closure glaucoma.

Increased trabecular pigmentation is a prominent sign and is apparent in virtually all patients with clinically evident disease. The pigment is

splotchy and less well defined. It is an early diagnostic finding preceding appearance of Pseudoexfoliation material on the pupillary margin and the anterior lens capsule. It is almost always dense in the involved eye and increases in eyes with Pseudoexfoliative glaucoma. The degree of pigmentation correlates with elevated intra-ocular pressure. Pigment on Schwalbe's line is seen as a wavy line known as Sampolesi's Line which is also an early sign of Pseudoexfoliation Syndrome.

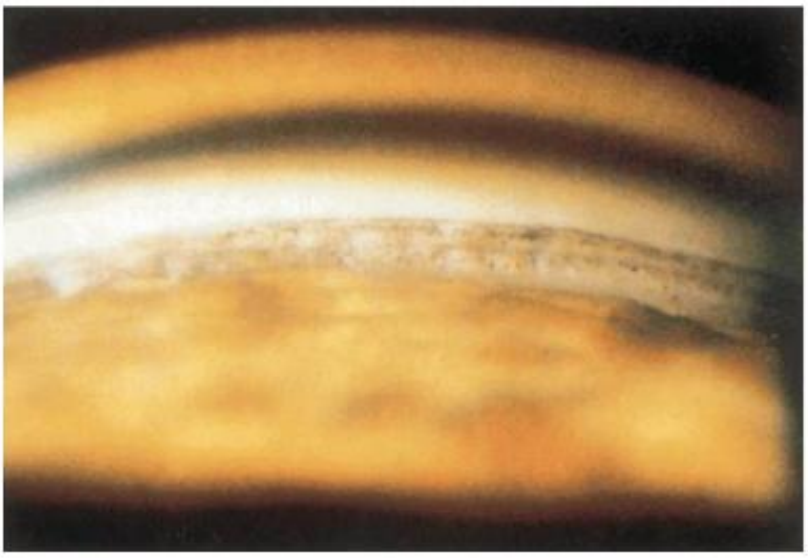


Fig. 9 : Gonioscopic view shows irregular pigmentation of trabecular meshwork and white flecks of exfoliative material.

f) VITREOUS

Vitreous changes commonly accompany Pseudoexfoliation Syndrome since hyaluronic acid and Pseudoexfoliation material are both acid mucopolysaccharides. A change in composition of aqueous in Pseudoexfoliation Syndrome could derange metabolism of hyalocytes leading to impaired production of hyaluronic acid and liquefaction.

g) CONJUNCTIVA AND CORNEA:

Clinically the Conjunctiva is normal. However, fluorescein angiography reveals loss of regular limbal vascular pattern and areas of neovascularisation and congestion of anterior ciliary vessels. Scattered flakes of Pseudoexfoliation material may be observed on the endothelial surface of the cornea. Specular microscopy demonstrates a significantly reduced endothelial cell density even with normal intra-ocular pressure, together with morphological changes in size and shape of the endothelial cells in both affected eyes and un-involved fellow eyes. Decreased endothelial cell density does not necessarily correlate with the severity of glaucoma but it has been correlated with the extent of pigment dispersion. Central corneal thickness is increased reflecting early corneal dysfunction. These changes may help in early diagnosis and in pre-operative assessment prior to cataract extraction. These eyes can develop early corneal endothelial decompensation at only moderate rises of intra-ocular pressure or after cataract surgery.

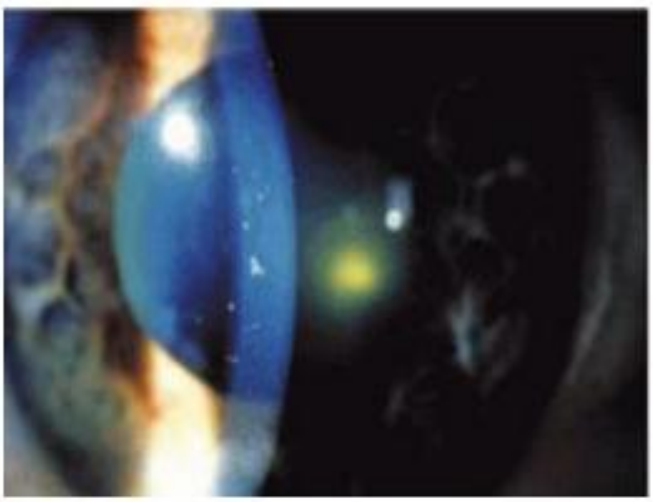


Fig. 10 : Exfoliation syndrome flakes on corneal endothelium

h) RETINA:

Both the increased rate of vitreous loss and the more frequent need of Nd: YAG capsulotomy for secondary cataract could be expected to enhance the risk of retinal detachment. The PEX syndrome might, therefore, be regarded as a risk factor for the development of retinal detachment. Furthermore, central retinal vein occlusion appears to be more common in patients with PEX syndrome.[1,35]

2. SYSTEMIC MANIFESTATIONS [35,37,38]

Ultrastructural studies performed on eyes during autopsy suggest that Pseudoexfoliation syndrome is a multisystem disorder, Pseudoexfoliation material has been found in a number of organs, which include skin, lungs, gallbladder, liver, myocardium, kidney, bladder and Meninges. Associations of aneurysms of abdominal aorta and Pseudoexfoliation syndrome have been extensively studied. The staining of the material in these organs is positive for elastin and human amyloid P protein, which is similar to the staining pattern characteristic of the material found in the eye. These findings provide evidence for the systemic nature of Pseudoexfoliation syndrome, which involves an aberrant connective tissue metabolism throughout the body. Patients with pseudoexfoliation syndrome are found to have sensory neural-deafness.

THEORIES ON ORIGIN OF PSEUDOEXFOLIATION MATERIAL

1. BASEMENT MEMBRANE THEORY:

There is extensive support for the hypothesis that pseudoexfoliation syndrome represents a disorder of extra-cellular matrix characterized by overproduction or abnormal breakdown of cell surface associated material, the biochemical nature of which remains unclear. With the advent of the electron microscope, extensive studies on the pseudoexfoliation material were done and its origin was ascribed to be basement membrane of the lens capsule, iris, cilliary body and conjunctiva. Schlotzer-Schrehardt et al[37] in 1992 confirmed systemic involvement of the viscera by pseudoexfoliation material using a transmission electron microscopy. Typical pseudoexfoliation fibers were identified in autopsy tissue specimens of skin, heart, lungs, liver, kidney and cerebral meninges in addition to the classic intraocular locations leading to the term pseudoexfoliation syndrome.

The production of the exfoliation material may be related to disordered basement membrane metabolism and Harnisch et al[39] in 1981 using the indirect immunoperoxidase method, found that the fibrils contained a basement membrane proteoglycan. Anti-basement membrane proteoglycan antibodies to lens material reacted strongly with exfoliation material, implicating lens epithelium and its production.

2. ELASTIC MICRO-FIBRAL THEORY

Since exfoliation material is immunologically related to elastic tissue, Li et al in 1989 proposed that exfoliation fibers have peripheral binding sites for Amyloid P protein similar to those present on normal elastic fibers. There

are histochemical and antigenic similarities between zonular elastic micro-fibrils and exfoliation material. Garner and Alexander[40] in 1984 suggested that Oxytalan, a micro-fibrillar component of elastic tissue present in the body in areas of mechanical stress is a constituent of the exfoliation fibrils. Roh et al in 1987 found mature and intermediate micro-fibrils adjacent to fibroblasts in close proximity to elastic tissue in the conjunctiva. Streeten et al[41] in 1987 found histochemical similarities between zonular elastic micro-fibrils and pseudoexfoliation material and a resemblance of the larger micro-fibrils of a ground substance to zonular and other oxytalan micro-fibrils. The strong anatomic association between pseudoexfoliation fibers with elastosis in conjunctival specimens led the authors to suggest that pseudoexfoliation fibers themselves might be a form of elastosis, possibly resulting from abnormal aggregation of components related to elastic micro-fibrils. Elastin and elastic micro-fibril protein were demonstrated in pseudoexfoliation material – their production might reflect an abnormal stimulus or defective regulation of matrix synthesis. Schlotzer – Schrehardt et al[42] in 1998 analyzed by electron microscopy the matrix of the pseudoexfoliation material and demonstrated in to be fibrilin positive fibers, supporting the elastic micro fibril theory of its production.

3. AMYLOID THEORY

Repo L.P. Naucharinen et al[43] in 1996 examined by light and electron microscopy 13 biopsy specimens of iris tissue from patients with pseudoexfoliation syndrome undergoing cataract surgery. They showed that pseudoexfoliation material is associated with amyloid and in some eyes;

miosis is associated with degenerative changes, both in stromal tissue and in muscular layers of the iris.

Tsukahara and Matsuo[44] described patients with both primary familial amyloidosis and exfoliation.

4. LYSOZOMAL THEORY

Mizuno et al[45] in 1980 found histochemical evidence of high acid phosphatase activity, suggesting that lysozymes were involved in the production of exfoliation material. Possible rupture of pigment epithelial cells may account for lyzosomal involvement. Proteolytic enzymes present in lyzosomes may facilitate granular disintegration.

Baba[46] in 1982 demonstrated a lipoprotein in exfoliation material and felt that this might be the result of the high permeability of vessels in the anterior segment. He also found that material was a sulphated glycosaminoglycan and suggested that abnormal glycosaminoglycan metabolism precedes the formation of the material.

Immunochemical studies have revealed heparin sulphate, chondroitin sulphate proteoglcans, laminin, entactin/nidogen, fibronectin and amyloid P protein to be integral constituents of exfoliation material. Type IV collagen is restricted to a micro-fibrillar layer interposed between the capsular surface and typical exfoliation material. Type IV collagen mediates cell attachment and might be instrumental in adherence of exfoliation material to the anterior central capsule. The additional presence of elastin epitopes indicate that exfoliation material is a multi-component expression of a disordered extra-cellular matrix synthesis, including the incorporation of the principle non-

collageneous basement membrane components. Extensive labeling of exfoliation material for chondroitin sulphate suggests an over-production and abnormal production of glycosoaminoglycans to be one of the key changes in this disorder. Exfoliation material contains but does not represent true basement membrane material because of absence of Type IV collagen and the additional presence of elastin epitopes.

Transmission electron microscopy and high resolution scanning electron microscopy and demonstrated pseudoexfoliation material to contain apilla and dermatan sulphate. They postulated that pseudoexfoliative material was produced due to abnormality in proteoglycans.

None of the histochemical or enzymatic studies have succeeded in elucidating the exact source of pseudoexfoliation material. This along with the increased chances of surgical complications continues to arouse great interest in pseudoexfoliation syndrome.

STRUCTURE OF PSEUDOEXFOLIATION MATERIAL

The Pseudoexfoliation Material consists of an irregular meshwork of randomly oriented cross-banded fibrils measuring about 30 nm in diameter within a loose fibro-granular matrix containing 6 – 10 nm micro fibrils.

Davanger[47,48] (1978) described the fibrils as consisting of a protein core surrounded by polysaccharide side chains. The fibrils are formed from lateral aggregations of filaments. The abnormally produced Pseudoexfoliation Material on light microscopy is a PAS positive, eosinophilic brush like nodular or feathery

aggregate. On scanning electron microscopy these aggregates are composed of an irregular tangle of fibrils.

The fibrils are intermingled with normal micro-fibrils and are embedded in an amorphous inter-fibrillar ground substance, most probably glycosoaminoglycans. The extra-ocular Pseudoexfoliation Material is similar except that there is more matrix and less distinct banding pattern.

Indirect histochemical and immune histochemical evidence suggests a complex glycoprotein/proteoglycan like structure composed of a protein core surrounded by glycol-conjugates probably glycosoaminoglycans forming the amorphous substance.

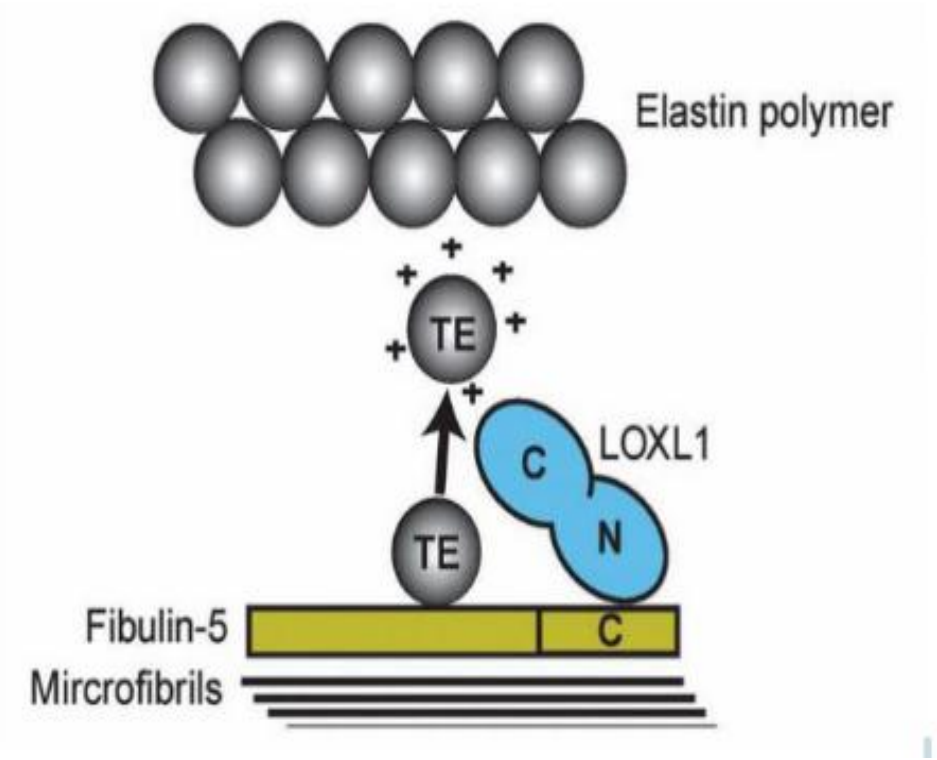


Fig. 11 : Basic building block of elastin, and catalyzing process for monomers to cross-link and form elastin.

SURGICAL CHALLENGES AND MANAGEMENT

PEX patients are five times more likely to develop intraoperative complications during cataract surgery compared to patients without the condition.[49]

SMALL PUPIL

Poor mydriasis due to pseudoexfoliation serves a major risk factor during cataract surgery. Small pupils could be enlarged by prosthetic and non prosthetic methods. Prosthetic techniques include visco mydriasis, manual iris stretching and iris microsphincterotomies.[50] Prosthetic devices generally provide more effective iris control than non prosthetic devices.

ZONULAR WEAKNESS

Zonular fragility has been suggested as the most important risk factor for capsular rupture and vitreous loss. Phacoemulsification causes less zonular stress than large incision extra capsular cataract surgery but localized zonular weakness may require capsular stabilization.[51] This may be achieved by using iris micro hooks to stabilize the capsule or implanting a capsular tension ring.

Exfoliation syndrome has created zonular tension so that the posterior capsule tension is flaccid, which makes cortex removal incomplete and capsular vacuuming impossible. As fibrosis progressed, substantial oblique striae developed with their apex at the area of retained cortex.

CAPSULAR TENSION RING

A CTR can distribute zonular tension evenly at the capsule equator, keeping the capsular bag stretched open during nucleus manipulation. It can prevent vitreous prolapse, improve IOL centeration, reduce tilt, reduce intraoperative zonule separation

and capsule rupture, and decrease capsule fibrosis. The CTR is indicated if there are <4 clock hour of zonulysis. May be inserted any time after the capsulorrhexis has been made. A capsular tension ring allows for the expansion and stabilization of the bag by redistributing forces with the resulting tautness of bag providing counter traction to facilitate phacoemusification and cortical aspiration.[52]

CAPSULAR PROBLEMS

Problems arise with initiation and completion of the capsulorrhexis due to capsular fibrosis and fragility, and lack of zonular support. Better visualization can be achieved with capsular staining dyes. A reasonably sized capsulorrhexis (>5mm) should be made to enable the nucleus or pieces of the nucleus to prolapse into the anterior chamber, thus minimizing zonular stress[4]; a large capsulorrhexis also helps prevent capsular phimosis, which is common in eyes with exfoliation syndrome and to avoid postoperative lens decentration.[1] All attempts must be made to enlarge and eccentric capsulorrhexis.

HYDRODISSECTION AND HYDRODELINETION

In the presence of a fragile capsule and poor capsular support, meticulous attention should be given to achieve a gentle decompression of the capsular bag and to avoid the capsular blockage syndrome. This occurs when a wave of hydrodissection is forced backward causing posterior capsular rupture. Hydro or viscodelineation of the nucleus[54,55] can be done so that all mechanical forces can be contained within the epinuclear space to minimize zonular stress.

CHOICE OF INTRAOCULAR LENS IMPLANT

Posterior capsular opacification (PCO) can be reduced by four quadrant hydrodissection, good sizing of the capsulorrhexis, excellent cortical cleanup, and cleaning of anterior capsule.[55] Studies have shown that IOL material and design have marked effects on the rate of PCO[56] and anterior capsular opacification [57] as well as the long term IOL centration[58] The IOL of choice may be the foldable three piece acrylic optic with polymethylmethacrylate haptics,[59] foldable silicone optic IOL with polyamide haptics, due to their ability to stabilize the capsule and resist the forces of fibrosis postoperatively. The IOL should be placed into the capsular bag, as this decreases the likelihood of fixation induced decentration.[60]

MANAGEMENT OF GLAUCOMA

Glaucoma associated with PXS can be particularly challenging to manage.[1] IOP can fluctuate considerably, and care should be taken when setting the target pressure range. Because of higher IOP fluctuation, some choose to set a lower target IOP and follow up these patients more closely. Patients with exfoliative glaucoma typically have an excellent response to prostaglandin analogues and laser trabeculoplasty, particularly argon laser trabeculopexy.[61,62]

When incisional surgical intervention becomes necessary, filtering surgery is generally advocated. One study suggested that exfoliative glaucoma has a poorer response to medical therapy than COAG but that it has a better response to trabeculectomy.[63] Cataract surgery may also decrease the IOP in patients with exfoliation syndrome and exfoliative glaucoma and open angles.

POST-OPERATIVE INFLAMMATION AND IOP CONTROL

There is an increased breakdown of the blood aqueous barrier in PEX patients compared to normal eyes post cataract surgery and PEX eyes are more prone for Postoperative inflammation.[64] Patients with PEX are prone for pseudo uveitis, formation of posterior synechiae and have to be observed for signs of persistent postoperative inflammation and treated appropriately.

LATE COMPLICATIONS

POSTERIOR CAPSULAR OPACITY

Secondary cataract (PCO) has been shown to be more frequent following cataract surgery in patients with PEX.[65] Due to aggravated blood-aqueous barrier breakdown, there is increased incidence of secondary cataract significantly in PEX eyes. The best approach for PCO is prevention. Clinically significant PCO is treated with Nd: YAG capsulotomy.

CAPSLAR CONTRACTION SYNDROME WITH OR WITHOUT IOL DECENTRATION

Davison first described capsule contraction syndrome in cases in which the was an exaggerated reduction in anterior capsulotomy and capsular bag diameter after extra capsular cataract surgery involving the use of a continuous curvilinear capsulorrhexis.[66] An imbalance of forces caused by zonular weakness results in an inability to resist the relatively increased strength of the centrally directed contractile forces generated by capsular fibrosis. A clinical study showed a significant increase in decentration of the entire capsular bag in PEX eyes.[67] Complete anterior capsular occlusion in a PEX patient has been reported despite capsular ring implantation.[68]

BAG LENS SUBLUXATION

Many patients with dislocated bag and lens (average 8.5-10years) post-uneventful cataract surgery (regular capsulorrhexis and IOL in the bag) have been noted in the literature and the major risk factors of concern are PXF and pre-operative irregular anterior chamber. To prevent the risk in future many surgeons recommend capsular tension ring in all patients with PXF. Other evolving new techniques are sulcus fixation with optic capture of a three piece IOL after CTR placement in the bag. The theory behind this is the IOL supports the bag, and the bag, which remains stretched due to CTR, supports the IOL. The lens remains centered by the capsulorrhexis and unable for the lens to decenter due to zonular weakness. There is also no centripetal force to challenge zonular integrity since the IOL optic fills the rhexis opening. Marked reduction in phacodonesis and iridodonesis and no capsular phimosis of capsules has beenobserved by this technique.[69]

PXS adds to the challenges of cataract surgery. Although some of these challenges are significant, with the use of dyes, capsule retractors, implant rings, better IOL choice, and meticulous attention to surgical technique, cataract surgery in PXS may be safely performed.

MATERIALS AND METHODS

TITLE OF THE STUDY:

CLINICAL STUDY OF INTRA OPERATIVE AND POST OPERATIVE COMPLICATIONS OF CATARACT SURGERY IN PATIENTS WITH PSEUDOEXFOLIATION.

SOURCE OF DATA:

All patients admitted with cataract and pseudoexfoliation admitted for the purpose of undergoing cataract extraction between OCTOBER 2015 – APRIL 2017 will be included in the study**.**

SAMPLE SIZE:

Population based studies from South India have reported the prevalence of Pseudoexfoliation to be between 3.8% and 6% among persons aged above 40 years(11). With prevalence rate taken as 4% at confidence level at 95% and margin of error at ±5, sample size worked out is 59.

$$n = [(1.96)^2 \times p \times q]/d^2$$

Where

n = Sample size

p = Prevalence rate

q = 100-p

d = margin of error

Therefore, a minimum of 59 cases are to be included in the study.

A total of 60 cases have been included in this study.

INCLUSION CRITERIA:

All patients aged 45 years and above of either sex diagnosed with PXF and cataract on the basis of slit lamp examination before and after pupillary dilatation selected for cataract surgery (manual small incision cataract surgery) during the study period.

EXCLUSION CRITERIA:

1. Patients with traumatic cataract.
2. Patients with Complicated cataract.
3. Patients with subluxated cataractous lens secondary to causes other than PXF.
4. Patients with significant eye diseases other than pseudoexfoliation and cataract responsible for visual loss (eg; corneal dystrophies and corneal degenerative diseases, posterior segment pathology)
5. Patients with open angle or closed angle glaucoma, where combined surgery is planned.

PREOPERATIVE EVALUATION.

1. Visual acuity testing for distance and near using Snellen's distant chart and near vision chart respectively.
2. Refraction and correction where required.
3. External ocular examination.
4. Slit lamp biomicroscopic examination for evidence of the following findings.
    - Pseudoexfoliation material in the pupillary margins.
    - Moth eaten appearance of the iris.
    - Morphological alterations of the cornea
    - Anterior chamber depth and pigment dispersion in the anterior chamber
    - Iridodonesis.

- Presence of posterior synechiae.
- Zones of Pseudoexfoliation on the anterior surface of the lens capsule.

Table A: Exfoliation Grade

Grade 0	None
Grade I (mild)	Exfoliation confined to the periphery of the lens and not seen unless the pupil is dilated.
Grade II (moderate)	Flakes of exfoliated material on the edge of the iris or on the surface of the lens capsule or both
Grade III (Serve)	Flakes of exfoliated material in the angle or on the posterior cornea surface.

- Phacodonesis or frank subluxation/dislocation of lens.
- Measurement of pupil size before and after dilatation of pupil.
- Pupillary reactions.

5. Tonometry using Applanation tonometer.
6. Gonioscopy with Goldmann three mirror lens in all patients with pseudoexfoliation syndrome. The following points were specifically evaluated.

- The extent of trabecular pigmentation which was graded as:

Table B: Grading of Trabecular pigmentation

Grade 0	→	Nil
Grade 1	→	Faint Pigmentation
Grade 2	→	Average Pigmentation
Grade 3	→	Moderate Pigmentation
Grade 4	→	Heavy Pigmentation

- The presence of pseudoexfoliation material in the angle.
- The presence of Sampolesi's line.
- The grading of angle width according to Shaffer's grading.

Table C: Shaffer's grading of Angle width

GRADE	ANGLE WIDTH (DEGREE)	CONFIGURATION	CHANCE OF CLOSURE	STRUCTURE VISIBLE ON GONIOSCOPY.
4	35-45	Wide open	Nil	From Schwalbe's line to cilliary body
3	20-35	open	Nil	From Schwalbe's line to sclera spur
2	20	Moderately narrow	Possible	From Schwalbe's line to trabecular meshwork
1	10	Very narrow	High	Schwalbe's line only
0	0	Closed	Closed	None of the structures visible.

7. The pupils were then dilated with a combination of 10% phenylephrine and tropicamide 1%, 1 drop was instilled every 5 minutes over a 15 minute interval.
8. This was followed by slit lamp examination for
    - Measuring pupil dilatation.
    - Examination of lens capsule for central and peripheral zones of pseudoexfoliation material deposition.
    - Evaluation of lens for the type of cataract.
9. Fundoscopy
10. Lacrimal patency test
11. Keratometry
12. A-scan and Intraocular lens power calculation by SRK-2 formula.

Other investigations included

- Urine examination for detection of sugar and albumin.

SURGICAL TECHNIQUE

All patients were given systemic antibiotics (tablet ciprofloxacin 500mg b.d.) on the preoperative day. On the day of surgery pupils were dilated adequately using instillation of 1% tropicamide and 5%/10% phenylephrine eye drops every 10 minutes, one hour before surgery. To sustain the pupil dilatation the anti-prostaglandin eye drops such as ibuprofen was instilled three times one day before surgery and half hourly for two hours immediately before surgery.

SURGICAL STEPS OF MANUAL SMALL INCISION CATARACT SURGERY

1. The eye to be operated is painted, draped and prepared for surgery under aseptic precautions.
2. Local anesthesia is given using 2% xylocaine mixed with 1500 units of hyaluronidase.
3. Universal wire speculum applied.
4. Superior rectus (bridle) suture is passed to fix the eye in downward gaze.
5. A small fornix based conjunctival flap is made, and sclera is exposed.
6. Haemostasis is achieved by applying gentle and just adequate wet field cautery.
7. A self sealing sclera-corneal tunnel incision is made.
8. Side-port entry is made with the help of 1.5mm valvular corneal incision at 9^0clock position.
9. Anterior capsulotomy by continuous curvilinear capsulorrhexis of adequate size is done.
10. Hydrodissection is done to separate cortico-nuclear mass from the posterior capsule.
11. Depending on the degree of mydriasis the pupil was stretched mechanically or sphincterotomies were done, depending on the operating surgeon's discretion.
12. Synechiolysis was done if required
13. Nucleus was delivered.
14. Cortical matter was removed by irrigation and aspiration.

15. In case of a posterior capsule tear, the integrity of the capsular bag was assessed to place the intraocular lens. In case of vitreous loss, manual anterior vitrectomy was done.
16. If there were no complications, posterior chamber intraocular lens was placed in the capsular bag.
17. The viscoelastic was cleared from the anterior chamber.
18. Subconjuntival gentamycin and dexamathasone 0.5cc was given at the end of the procedure.
19. Pad and bandage applied.

Postoperatively all the patients received a course of topical antibiotic and steroid eye drops one hourly, systemic antibiotic was given for 3 days postoperatively.

Table D: The extent of uveitis was graded

Mild +	Mild ciliary congestion, anterior chamber flare grade 1-2
Moderate ++	Moderate ciliary congestion, anterior chamber flare grade 3
Severe ++	Severe ciliary congestion, anterior chamber flare grade 4.

STATISTICAL ANALYSIS

All characteristics were summarized descriptively. For continuous variables, Data were represented using Mean ±SD. For categorical data, the number and percentage were used in the data summaries and diagrammatic presentation. Data were analyzed using SPSS software v.23.0. and Microsoft office.

OBSERVATION AND RESULTS

Total patients for cataract surgery – 1519

Total patients diagnosed with PXF – 60

Prevalence – 3.95%

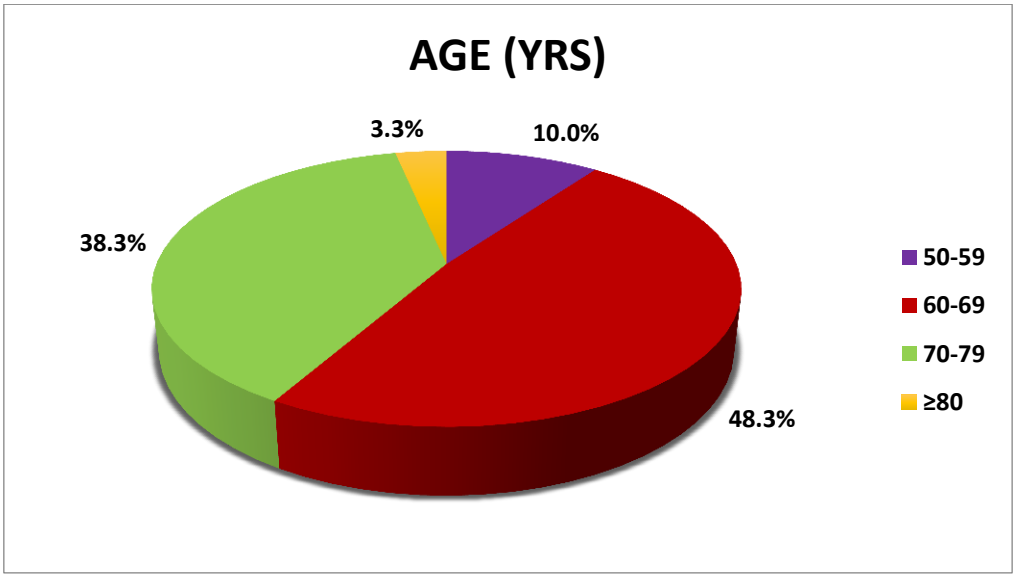
Table 1a: AGE DISTRIBUTION IN PATIENTS WITH PSEUDOEXFOLIATION SYNDROME

AGE (YRS)	N	%
50-59	6	10.0
60-69	29	48.3
70-79	23	38.3
≥80	2	3.3
TOTAL	60	100.0

Table 1b: MEAN AGE OF PATIENTS WITH PSEUDOEXFOLIATION

Parameter	Min	Max	Mean	SD
Age (yrs)	50	90	66.0	8.1

GRAPH 1: AGE DISTRIBUTION IN PATIENTS WITH PSEUDOEXFOLIATION SYNDROME



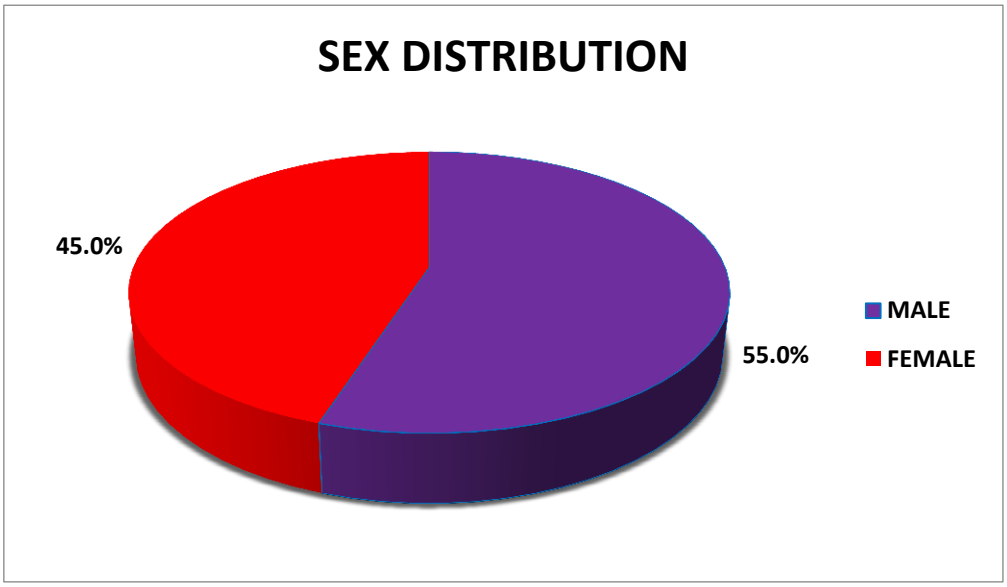
In the present study, there were 6 (10 %) patients of age group 50 – 59 years, 29 (48.3%) patients of age group 60 – 69 years, 23 (38.3 %) of age group 70 – 79 and 2 (3.3%) patients in the age group of ≥80 years.

The minimum age of patients included in this study was 50 and maximum was 90 years. Average age of patients was 66 years with a standard deviation of 8.1 years.

Table 2: SEX DISTRIBUTION IN PSEUDOEXFOLIATION SYNDROME

SEX	N	%
MALE	33	55.0
FEMALE	27	45.0
TOTAL	60	100.0

GRAPH 2: SEX DISTRIBUTION IN PSEUDOEXFOLIATION SYNDROME

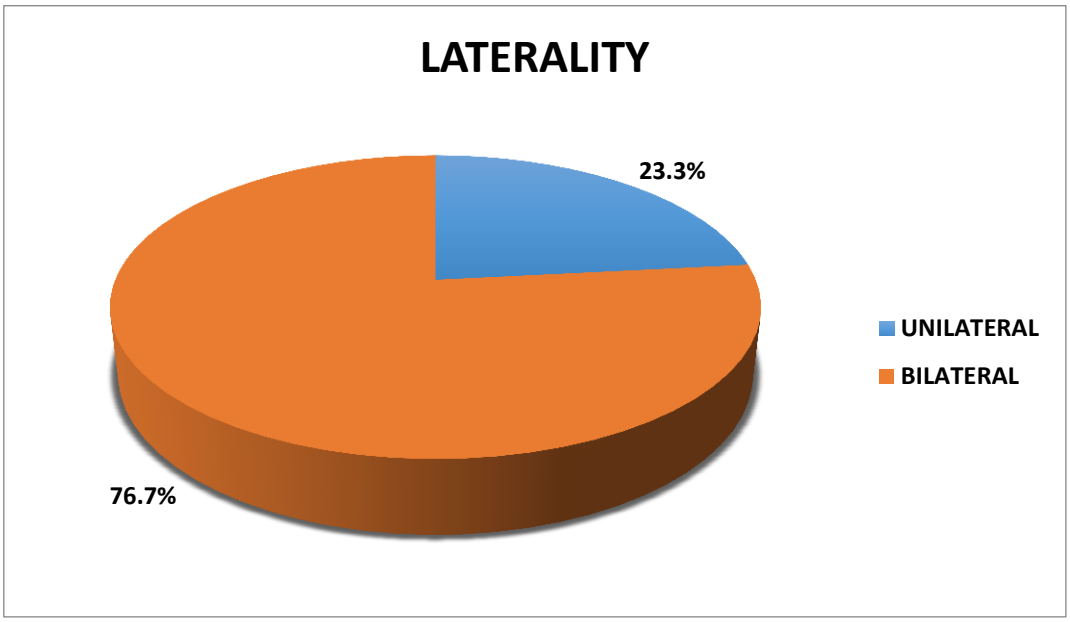


In the present study, there were 33 (55%) were males and 27 (45%) were females. No significant difference was seen between incidence in male and female.

Table 3: LATERALITY IN EYES WITH PSEUDOEXFOLIATION SYNDROME

LATERALITY	N	%
UNILATERAL	14	23.3
BILATERAL	46	76.7
TOTAL	60	100

GRAPR 3: LATERALITY IN EYES WITH PSEUDOEXFOLIATION SYNDROME

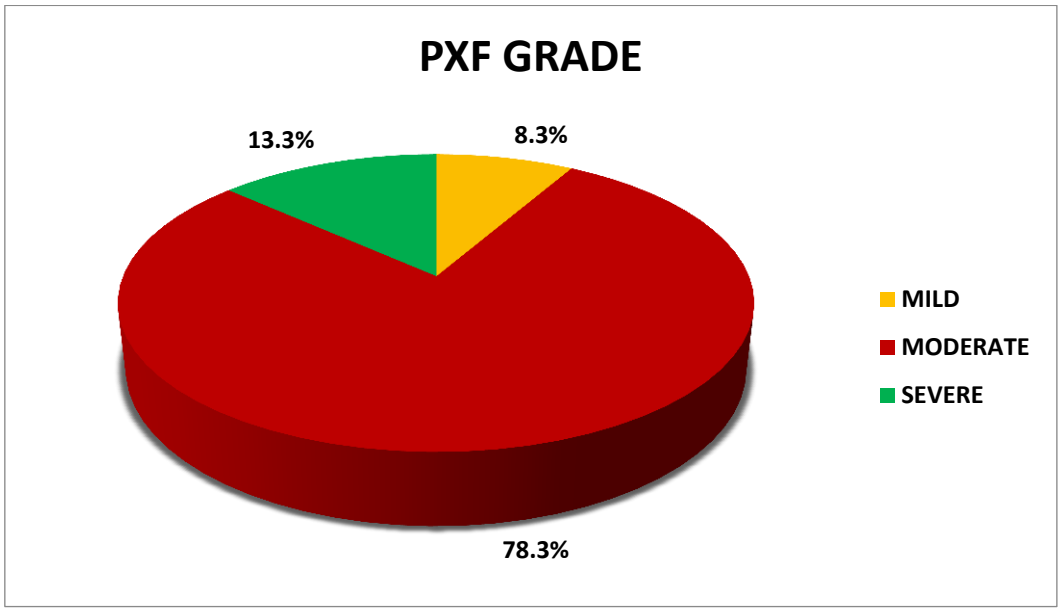


In the present study there were 14 (23.3) patients had clinical unilateral involvement of Pseudoexfoliation syndrome and 46 (76.7) had bilateral involvement.

Table 4: GRADE OF PXF

PXF GRADE	N	%
MILD	5	8.3
MODERATE	47	78.3
SEVERE	8	13.3
TOTAL	60	100.0

GRAPH 4: GRADE OF PXF



13.3% had mild PXF, diagnosed post-mydriasis with deposits on the lens capsule, 78.3% had moderate grade PXF, and 8.3% had severe PXF.

Table 5 : PRE-OPERATIVE IOP in PXF

IOP	PRE OPERATIVE	
	N	%
≤10	6	10.0
11-20	54	90.0
>20	0	0.0
TOTAL	60	100.0

GRAPH 5 : PRE POERATIVE IOP in PXF

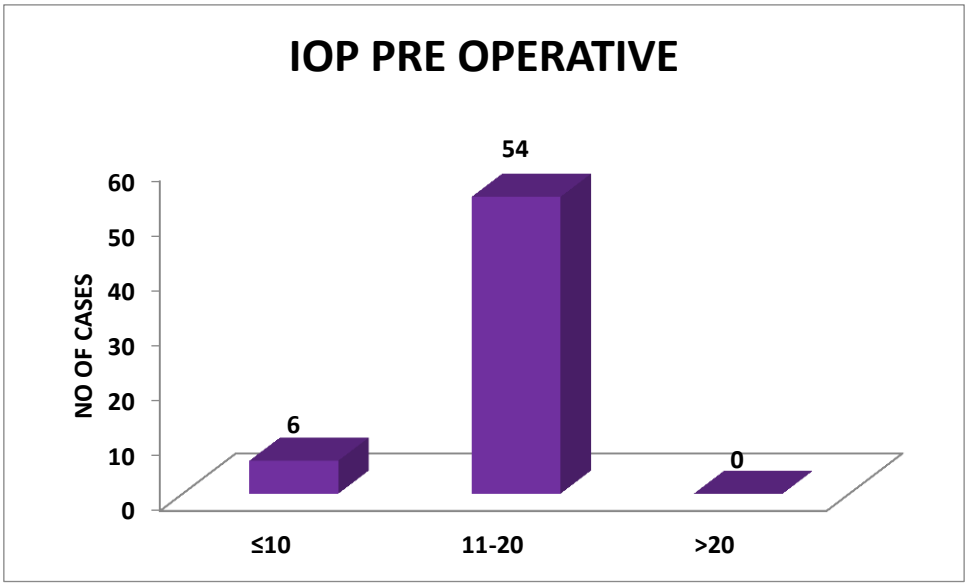
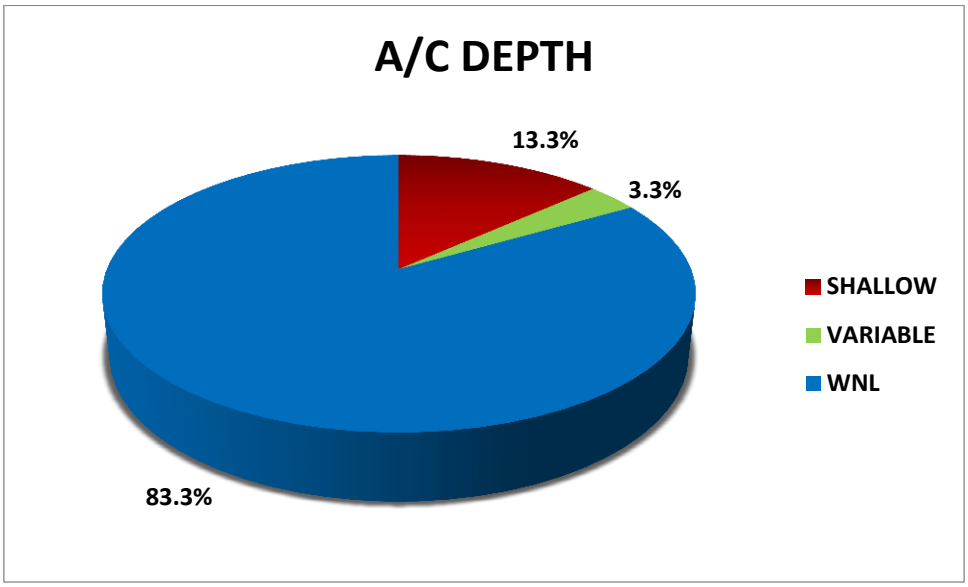


Table 6: A/C DEPTH – as per Van Herrick's grading

A/C DEPTH	N	%
SHALLOW	8	13.3
VARIABLE	2	3.3
WNL	50	83.3
TOTAL	60	100.0

GRAPH 6 : A/C DEPTH

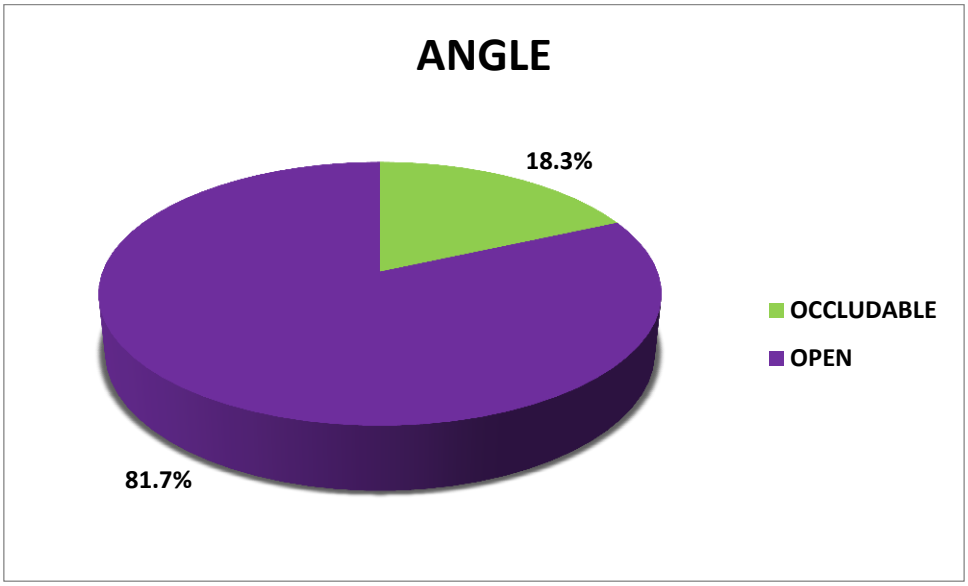


13.3% patients had shallow anterior chamber per Van Herrick's grading preoperatively

Table 7: ANGLE CHARACTERISTICS

ANGLE	N	%
OCCLUDABLE	11	18.3
OPEN	49	81.7
TOTAL	60	100.0

GRAPH 7: ANGLE CHARACTERISTICS

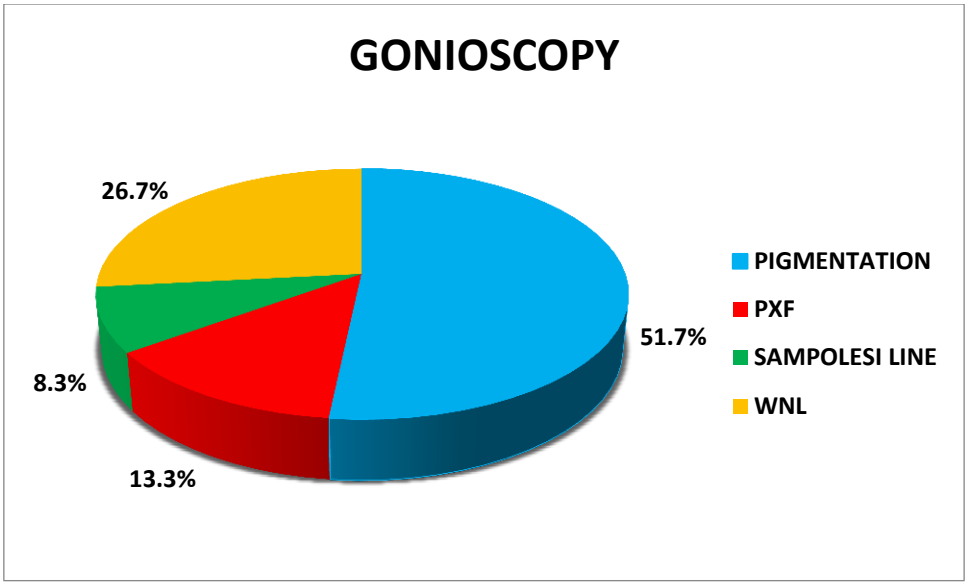


81.7% of the eyes had open angle, 18.3 % had occludable angle.

Table 8: GONIOSCOPY FINDINGS

GONIOSCOPY FINDINGS	N	%
PIGMENTATION	31	51.7
PXF	8	13.3
SAMPOLESI LINE	5	8.3
WNL	16	26.7
Total	60	100.0

GRAPH 8: GONIOSCOPY FINDINGS

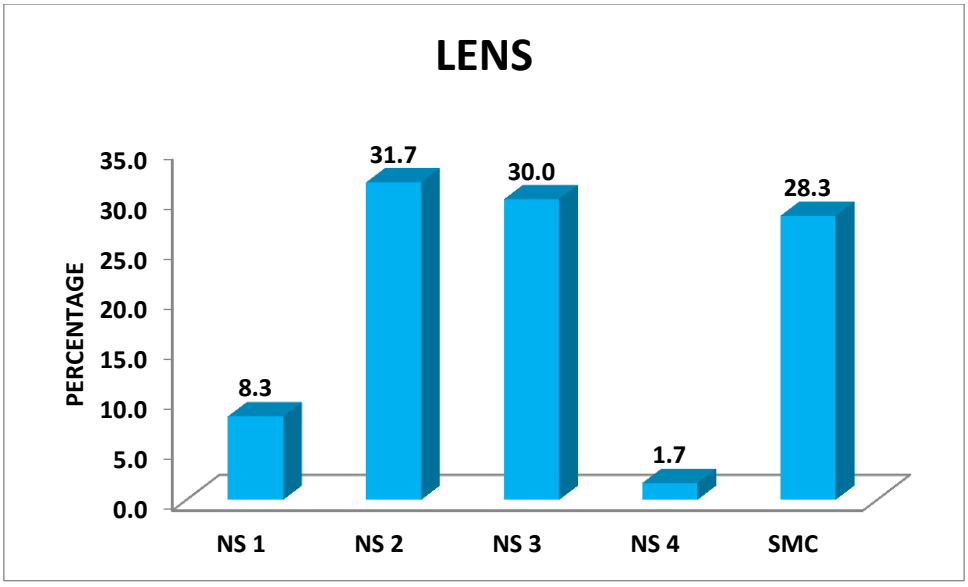


On Gonioscopy, 31 (51.70%) showed pigment deposition over trabecular meshwork, 8 (13.3%) showed pseudoexfoliative material in the angle, in 5 (8.3%) cases Sampolesi line was visible and 16 (26.7%) were within normal limits.

Table 9a: TYPE OF CATARACT

LENS	N	%
NS 1	5	8.3
NS 2	19	31.7
NS 3	18	30.0
NS 4	1	1.7
SMC	17	28.3
Total	60	100.0

GRAPH 9a: TYPE OF CATARACT

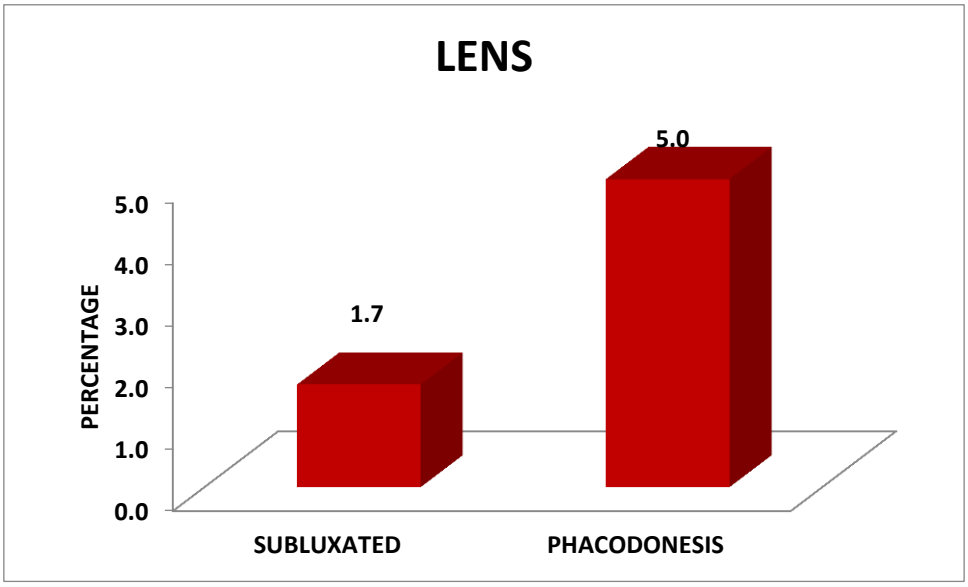


In the present study, 17 (28.3%) of the patients had Mature Cataract and 43 (71.7 %) of them had Immature cataract with Pseudoexfoliation syndrome.

Table 9b: PRE- OPERATIVE LENS COMPICATIONS:

LENS	N	%
SUBLUXATED	1	1.7
PHACODONESIS	3	5.0

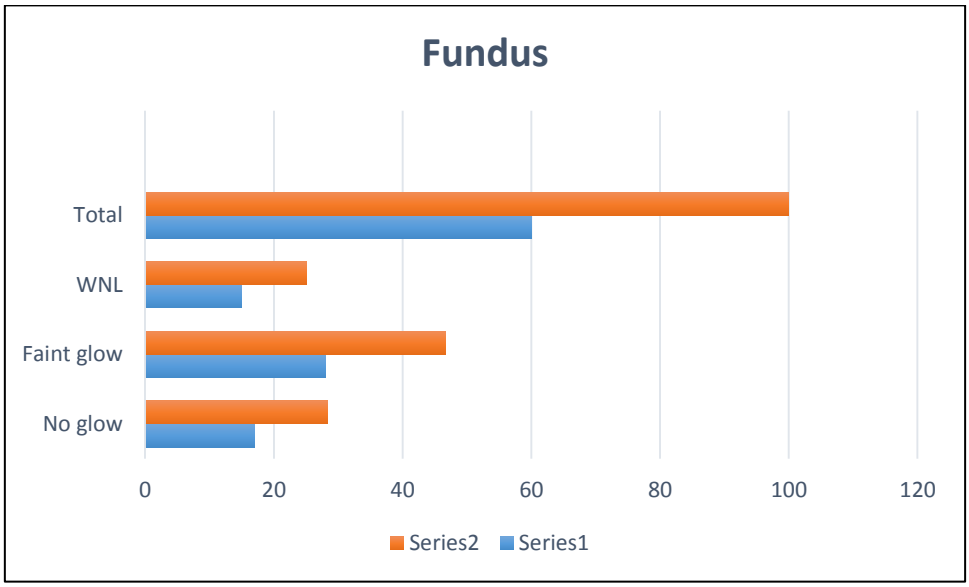
GRAPH 9b: PRE- OPERATIVE LENS COMPICATIONS



1 (1.7%) had subluxated lens and 3 (5%) had phacodonesis.

Table 10: FUNDUS

FUNDUS	N	%
NO GLOW	17	28.3
FAINT GLOW	28	46.7
WNL	15	25
TOTAL	60	100.0



Graph 10: Fundus

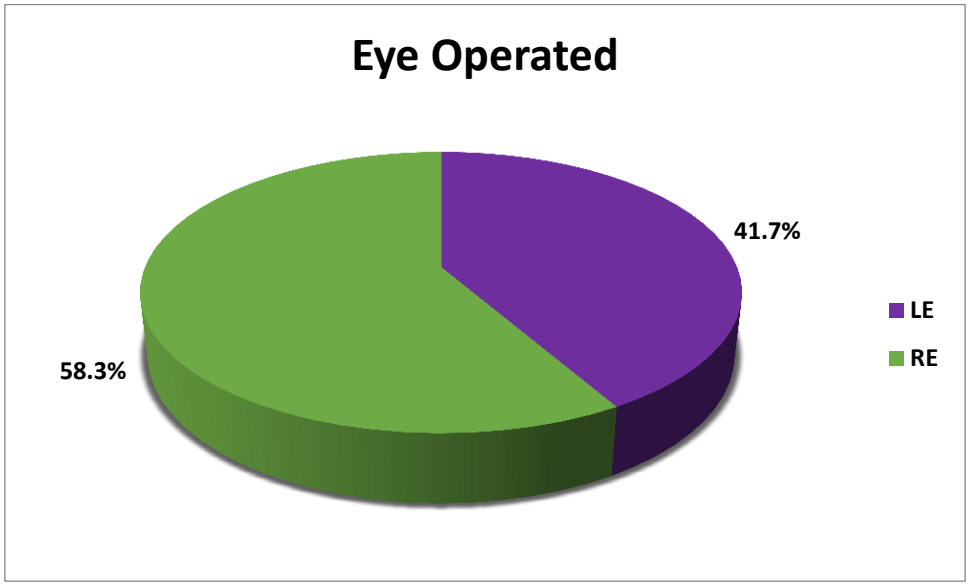
43 (71.7%) of fundus were within normal limits while fundus could not be visualized in 17 (28.3%).

INTRAOPERATIVE OBSERVATIONS:

Table 11: EYE OPERATED

INTRA OP	N	%
LE	25	41.7
RE	35	58.3
TOTAL	60	100.0

GRAPH 11: EYE OPERATED

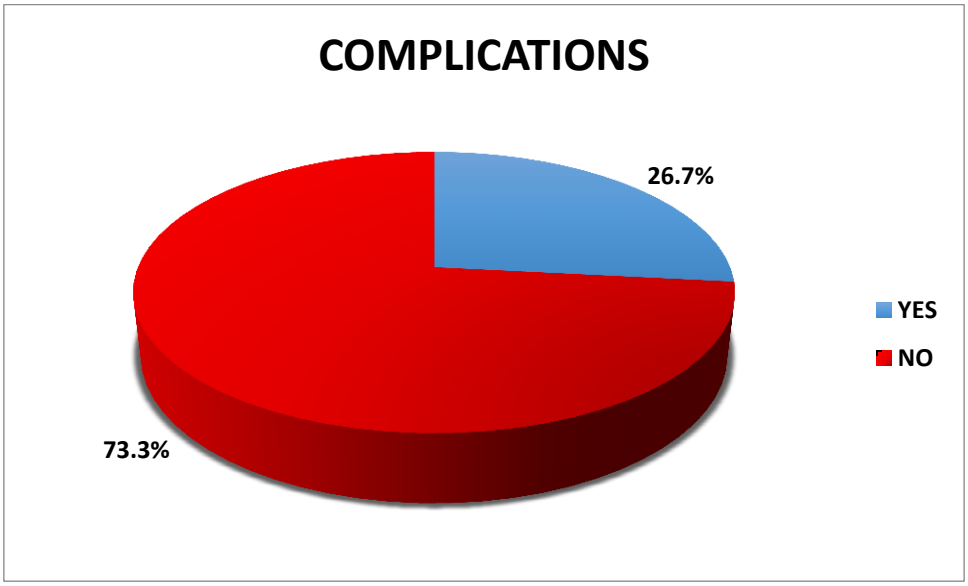


In 35 (58.3 %) out of 60 cases, Right eye was operated.

Table 12: INCIDENCE OF INTRA-OPERATIVE COMPLICATIONS

COMPLICATIONS	N	%
YES	16	26.7
NO	44	73.3
TOTAL	60	100.0

GRAPH 12: INCIDENCE OF INTRA-OPERATIVE COMPLICATIONS

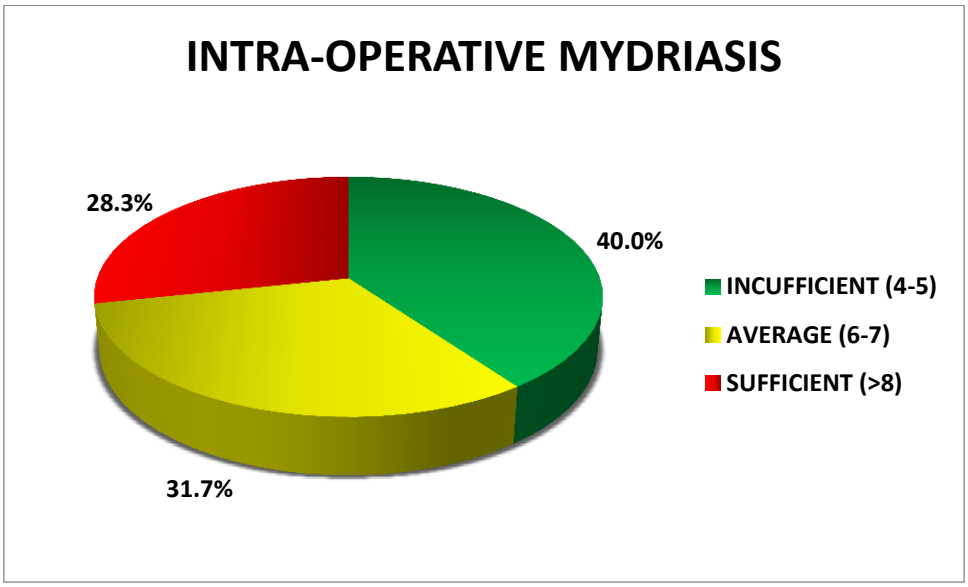


In the present study, intraoperative complication(s) occurred in 16 (26.7%) cases.

Table 13: INTRA-OPERATIVE MYDRIASIS

Mydriasis (mm)	N	%
INCUFFICIENT (4-5)	24	40.0
AVERAGE (6-7)	19	31.7
SUFFICIENT (>8)	17	28.3
TOTAL	60	100.0

GRAPH 13: INTRA-OPERATIVE MYDRIASIS

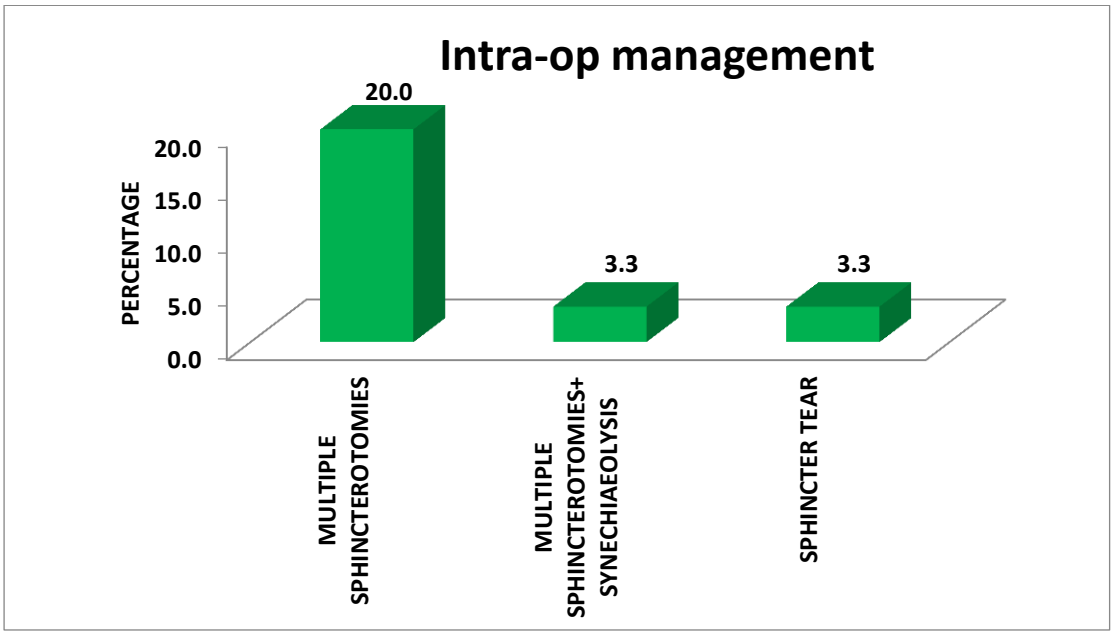


In this study, 24 (40%) patients had inadequate mydriasis preoperatively, 19 (31.7%) had average mydriasis and 17 (28.3%) had adequate mydriasis.

Table 14: MANAGEMENT OF INSUFFICIENT INTRA – OPERATIVE MYDRIASIS

MANAGEMENT	N	%
MULTIPLE SPHINCTEROTOMIES	12	20.0
MULTIPLE SPHINCTEROTOMIES+SYNECHIAEOLYSIS	2	3.3
SPHINCTER TEAR	2	3.3

GRAPH 14: MANAGEMENT OF INSUFFICIENT INTRA – OPERATIVE MYDRIASIS

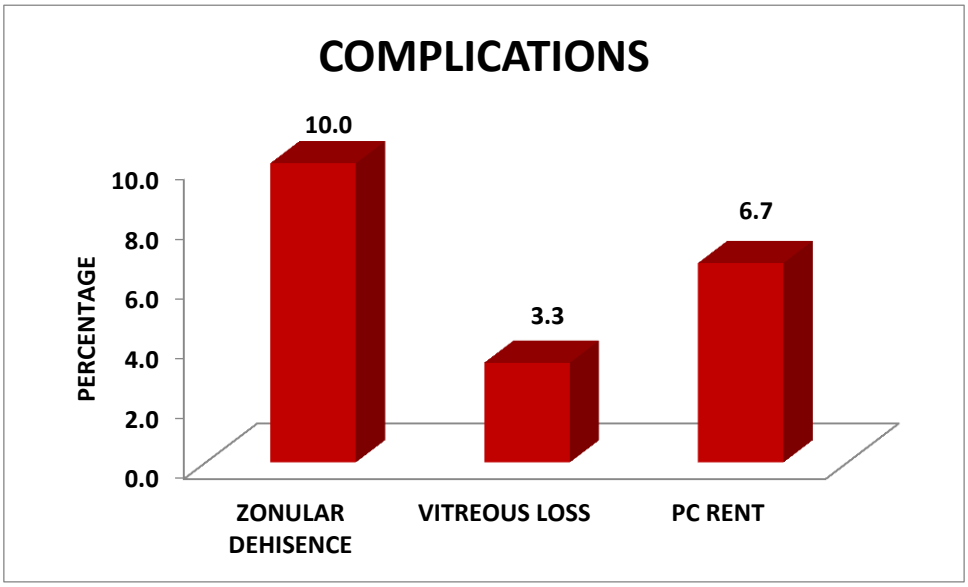


Intra operative surgical manipulations were carried out in the form of multiple sphincterotomies in 12 (20%) patients and sphincterotomies + synaechiolysis in 2(3.3%) patients.

Table 15: TYPE OF COMPLICATION

COMPLICATIONS	N	%
ZONULAR DEHISCENCE	6	10.0
VITREOUS LOSS	2	3.3
PC RENT	4	6.7

GRAPH 15: TYPE OF COMPLICATION

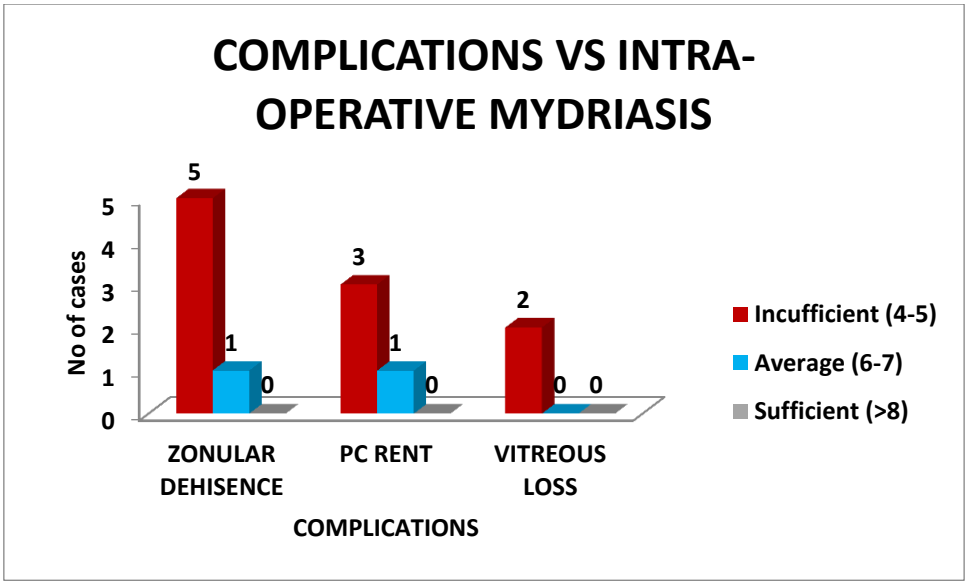


Zonular dehiscence occurred in 6(10%), PC rent in 4(6.7%) and vitreous loss in 2 (3.3%).

Table 16: COMPLICATIONS VS INTRA-OPERATIVE MYDRIASIS

COMPLICATIONS	Incufficient (4-5)	Average (6-7)	Sufficient (>8)	Total	p value
ZONULAR DEHISENCE	5	1	0	6	0.049
PC RENT	3	1	0	4	0.136
VITREOUS LOSS	2	0	0	2	0.107

GRAPH 16: COMPLICATIONS VS INTRA-OPERATIVE MYDRIASIS

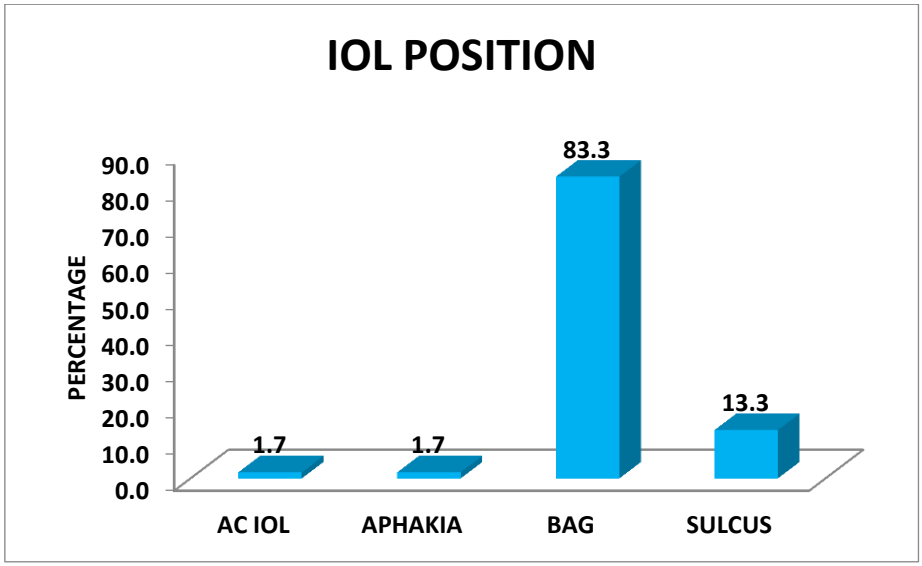


5 of the 6 patients who had zonular dilatation, 3 of the 4 patents who had PC rent and both patients with vitreous loss had insufficient pupillary dilatation.

Table 17: POSITION OF IOL

IOL POSITION	N	%
AC IOL	1	1.7
APHAKIA	1	1.7
BAG	50	83.3
SULCUS	8	13.3
TOTAL	60	100.0

GRAPH 17: POSITION OF IOL



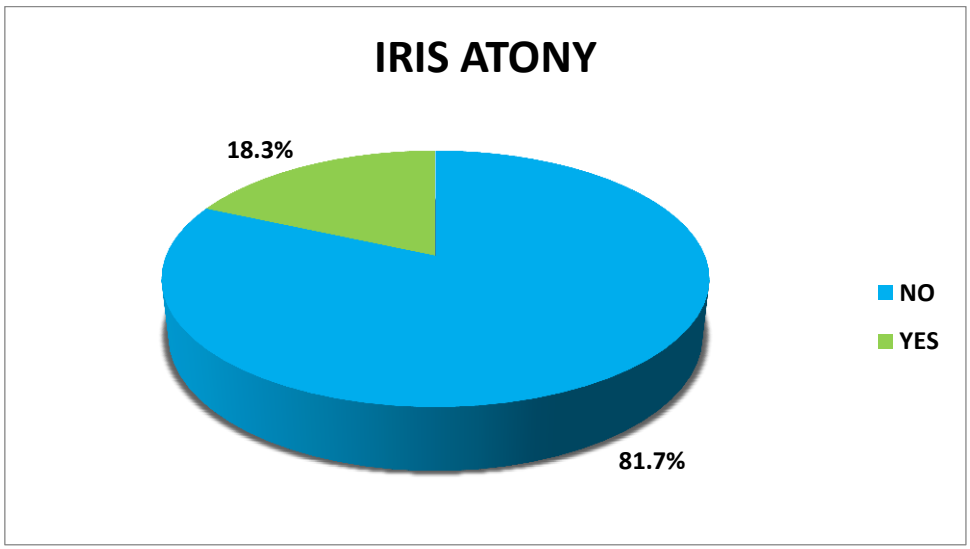
58 (96.6%) patients PCIOL was inserted. Out of this, 50 (83.3%) were placed in the bag and (13.3%) were placed in the sulcus.

In 1 (1.7%) patient ACIOL was inserted and 1 (1.7%) patient was left aphakic.

Table 18: IRIS ATONY

IRIS ATONY	N	%
NO	49	81.7
YES	11	18.3
TOTAL	60	100.0

GRAPH 18: IRIS ATONY



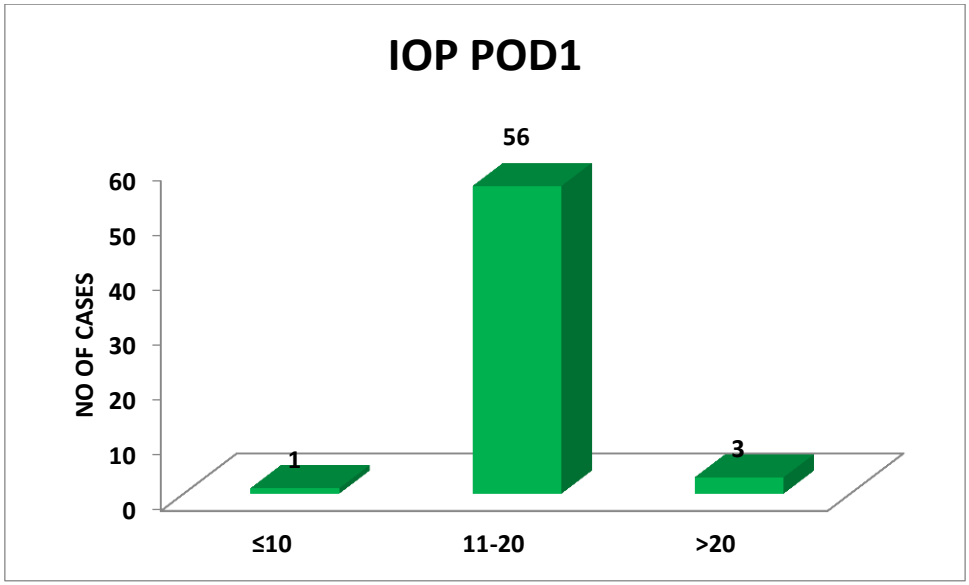
Atony of iris was seen in 11 (18.3%) patients intra-operatively.

IMMEDIATE POST OPERATIVE PERIOD

Table 19 a : IOP – POST OP DAY 1

IOP	POD 1	
	N	%
≤10	1	1.7
11-20	56	93.3
>20	3	5.0
TOTAL	60	100.0

GRAPH 19 a : IOP – POST OP DAY 1

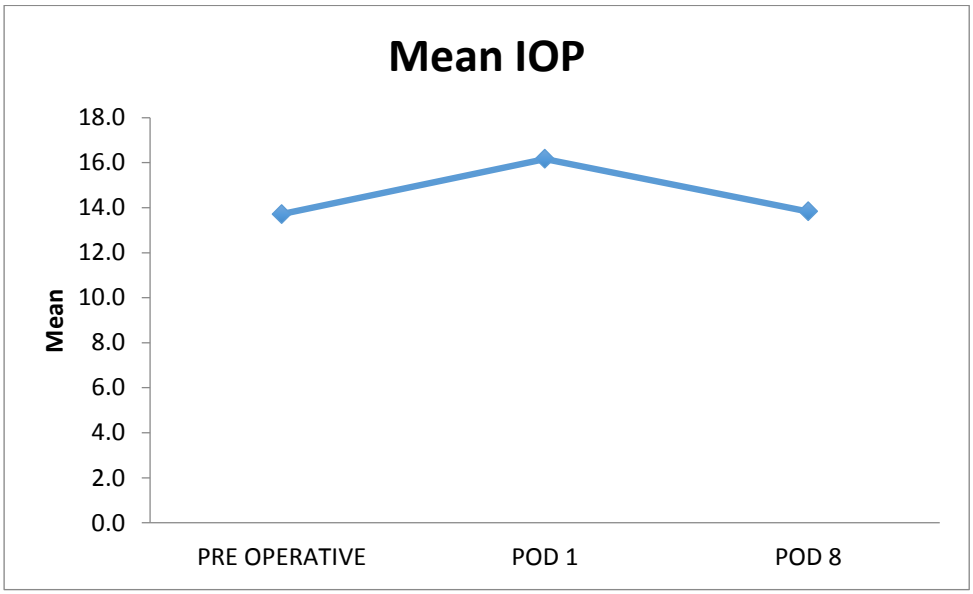


56 (93.3%) patients had IOP between 11-20 mmHg and 3 (5%) had an IOP of >20 mmHg on post of day 1.

Table 19 b: MEAN IOP ACCORDING TO POD

	Range		IOP	
	Min	**Max**	**Mean**	**SD**
PRE OPERATIVE	10	19	13.7	2.3
POD 1	10	29	16.2	3.1
POD 8	10	18	13.8	2.1

Graph 19 b: MEAN IOP ACCORDING TO POD

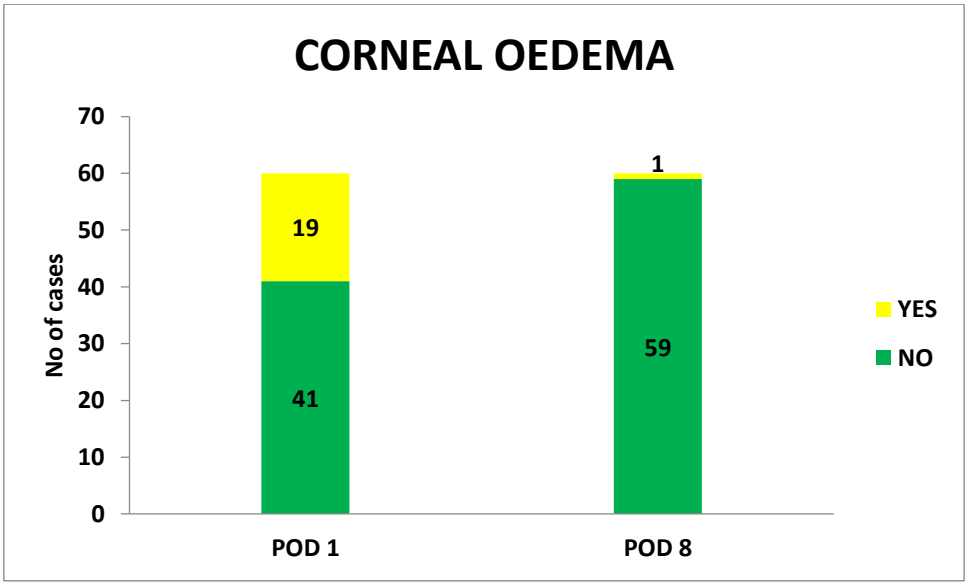


On POD 1 mean IOP was 16.2 mmHg +/- 3.1 mmHg, which fell to 13.8mmHg +/- 2.1mmHg by POD 8.

Table 20: CORNEA (Oedema/SK/Normal)

PARAMETERS	POD 1		POD 8	
CORNEAL OEDEMA	**N**	**%**	**N**	**%**
NO	41	68.3	59	98.3
YES	19	31.7	1	1.7
TOTAL	60	100.0	60	100.0
SK	**N**	**%**	**N**	**%**
NO	39	65.0	59	98.3
YES	21	35.0	1	1.7
TOTAL	60	100.0	60	100.0

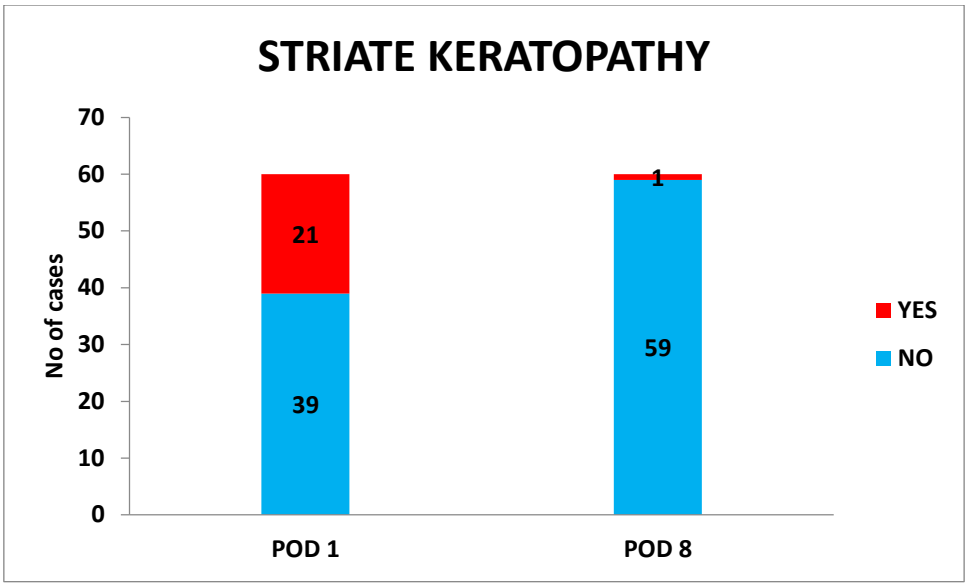
GRAPH 20a: CORNEAL OEDEMA ON POD 1 AND POD 8



Corneal oedema was seen in 19 (31.7%) of cases on post op day 1.

By post op day 8, only 1 (1.7%) had corneal oedema.

GRAPH 20b: STRIATE KERATOPATHY ON POD 1 AND POD 8



Striate keratopathy was seen in 21 (35%) patients on post op day. By day 8 only 1 (1.7%) patient had SK.

Table 21a: POST-OPERATIVE PUPIL CHARACTERISTICS

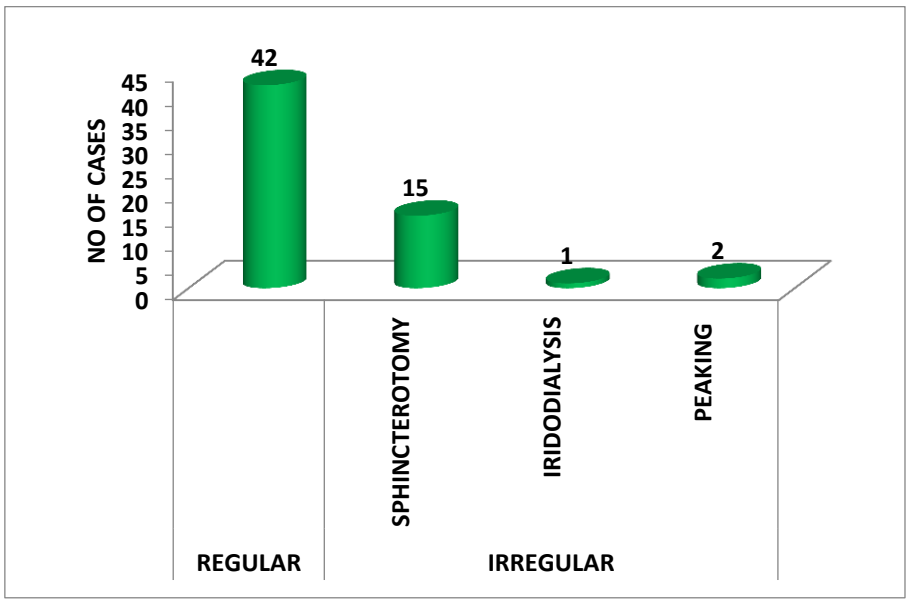
PUPIL	REGULAR		IRREGULAR	
	N	%	N	%
	42	70.0	**18**	30.0

In this study, 42 (70%) had regular pupils and 18 (30%) had irregular pupils.

Table 21b: POST-OPERATIVE CAUSES OF IRREGULAR PUPIL

PUPIL	IRREGULAR					
	SPHINCTEROTOMY		IRIDODIALYSIS		SPHINCTER TEAR	
	N	%	N	%	N	%
	15	25.0	1	1.7	2	3.3

GRAPH 21: POST-OPERATIVE PUPIL CHARACTERISTICS

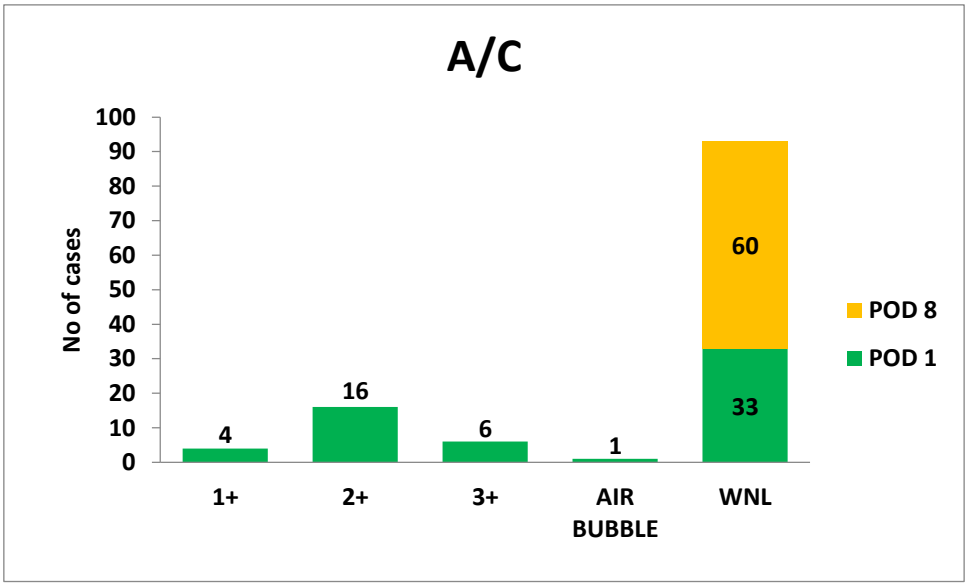


15 (25%) of patients had irregular pupil due to sphincterotomies, 1 (1.7%) due to iridodialysis and 2 (3.3%) due to peaking.

Table 22: A/C REACTION IN IMMEDIATE POST-OPERATIVE PERIOD

A/C	POD 1		POD 8	
	N	%	N	%
1+	4	6.7	0	0
2+	16	26.7	0	0
3+	6	10.0	0	0
AIR BUBBLE	1	1.7	0	0
WNL	33	55.0	60	100.0
TOTAL	60	100.0	60	100.0

GRAPH 22: A/C REACTION IN IMMEDIATE POST-OPERATIVE PERIOD



In this study, +3 reaction was seen in 6 (10%) and +2 reaction was seen in 16 (26.7%) patients on post of day 1. The reaction cleared by post op day 8 in all patients.

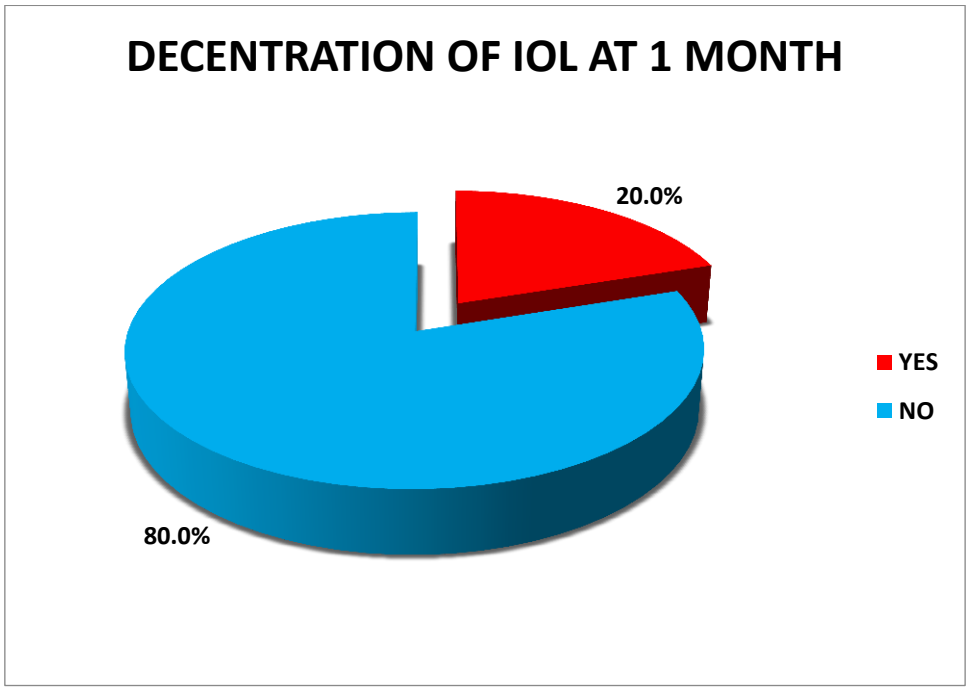
INTERMEDIATE POST-OPERATIVE PERIOD

1 MONTH

Table 23: DECENTRATION OF IOL AT 1MONTH

DECENTRATION OF IOL AT 1 MONTH	N	%
YES	12	20.0
NO	48	80.0
TOTAL	60	100.0

GRAPH 23: DECENTRATION OF IOL AT 1MONTH



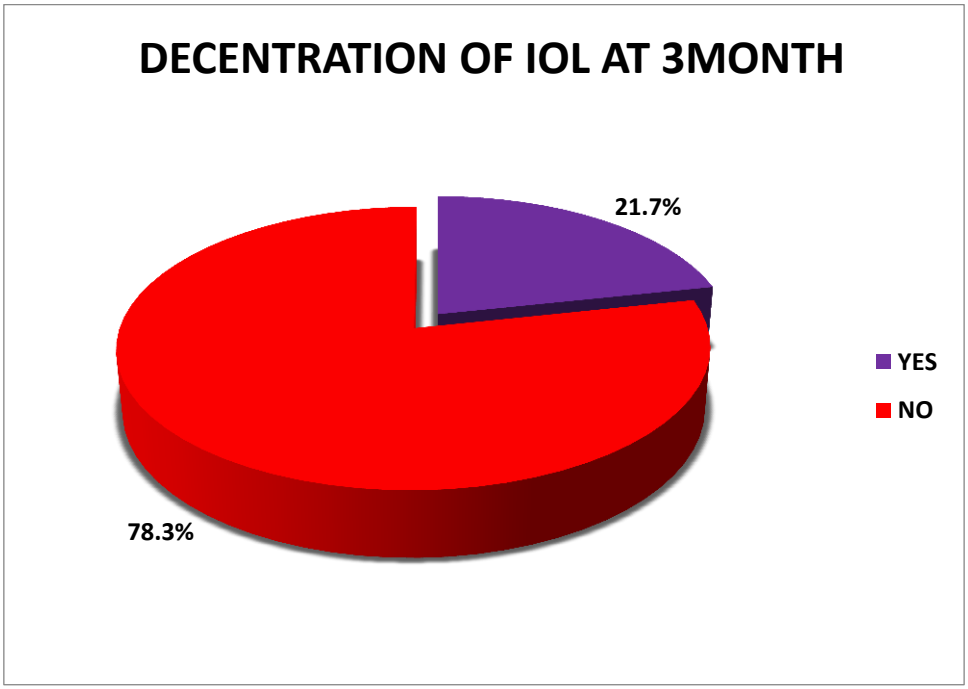
Decentration of IOL was seen in 12 (20%) patients at 1 month follow up.

3 MONTHS

Table 24: DECENTRATION OF IOL AT 3 MONTHS

DECENTRATION OF IOL AT 3 MONTHS	N	%
YES	13	21.7
NO	47	78.3
TOTAL	60	100.0

GRAPH 24: DECENTRATION OF IOL AT 3 MONTHS

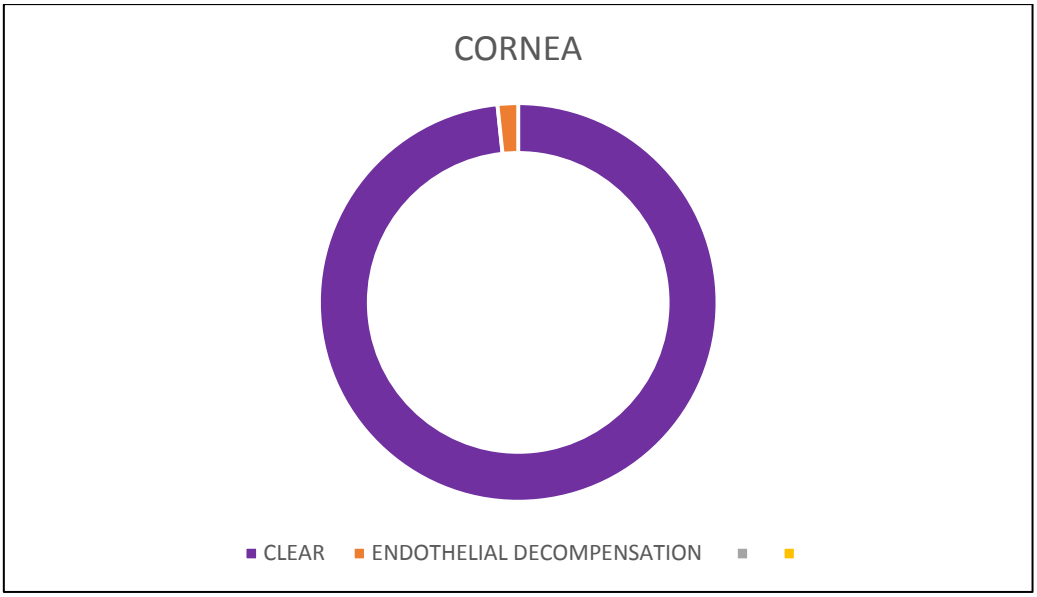


Decentration of IOL was seen in 13 (20%) patients at 3 months follow up.

TABLE 25: STATUS OF CORNEA AT 3 MONTHS

CORNEA	N	%
CLEAR	59	98.3
ENDOTHELIAL DECOMPENSATION	1	1.7%
TOTAL	60	

GRAPH 25: STATUS OF CORNEA AT 3 MONTHS

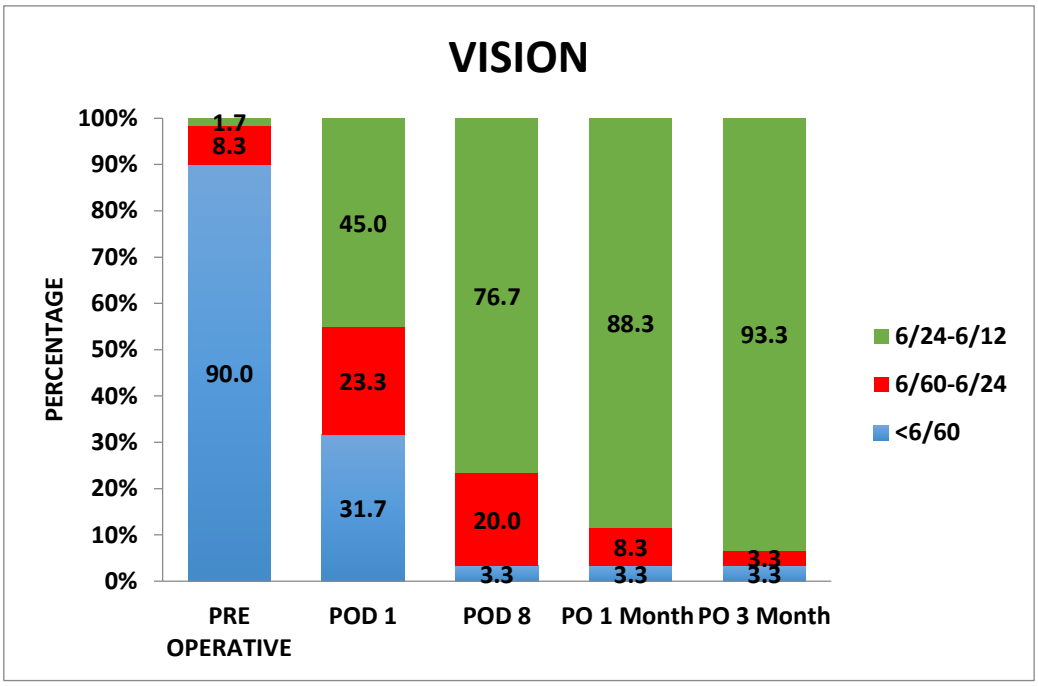


1 (1.7%) had corneal endothelial decompensation in the study.

TABLE 26: VISUAL OUTCOME

VISION	PRE OPERATIVE		POD 1		POD 8		PO 1 Month		PO 3 Month		p value
	N	%	N	%	N	%	N	%	N	%	
<6/60	54	90.0	19	31.7	2	3.3	2	3.3	2	3.3	
6/60-6/24	5	8.3	14	23.3	12	20.0	5	8.3	2	3.3	<0.001*
6/24-6/12	1	1.7	27	45.0	46	76.7	53	88.3	56	93.3	

GRAPH 26: VISUAL OUTCOME



Preoperatively 90% patients had a vision of 6/60 or lesser. Post operatively on day 1 45% patients achieved vision of 6/24 – 6/12. By Post operative 3 months 93.3% patients achieved a vision of 6/24 – 6/12.

DISCUSSION

A Prospective longitudinal hospital based study was carried out among patients who had cataract and pseudoexfoliation, selected for Manual Small Incision Cataract surgery with PCIOL implantation. This study was carried out from October 2015 to April 2017.

Prevalence of PXF

A total of 1519 patients underwent cataract extraction from October 2015 to April 2017. Based on the inclusion and exclusion criterion elucidated above, 60 patients were enrolled in the study.

A sum of 60 patients out of 1519 were diagnosed with PXF, showing a prevalence rate of 3.95% this study.

Table 27: Comparison of our study with previous literature

Sood and Ratnaraj (1968)18	Lamba and Giridhar (1984)19	Aravind H, Raju B et al (2003)11	Tarek A Shazly et al(2011)13	Present study (2017)
1.87%	7.4%	3.8%	4.14%	3.95%

Table 28: Prevalence of PXF

Studies	Prevalence	Mean age of those with PEX	Gender association with PEX	Unilateral Vs bilateral PEX
Present study	3.95%	66 years	4.05% males	76.7%
Arvind eye survey (20)	6%	63 years (median)	Males 7.7%	70%
Lamba et al (19)	7.4%	-	Male incidence 8.5%	56.8%
Raju, Paul et al (11)	3.8%	64.7 years	No sex predilection	50.9%

Age and sex distribution

48.3% of the patients presented between 60-69 years and the average age of presentations was 66 years. 90% of PXF patients presented after 60 years. As per the incidence charting, the incidence of PXF increased as the age at presentation for cataract advanced, hence prevalence of PXF as such in cataract patients increases in the elderly population. Increased incidence of PXF with age is known according to various studies.[4, 21, 22]

Incidence of PXF in males was 4.05% and incidence among females was 3.7%. Age distribution of males and females showed that females presented at a younger age group when compared to males.

Studies regarding the sex distribution of PXF have found no predilection towards either sex, although few studies have reported a female preponderance.[68]

Unilateral versus Bilateral

76.7% of patients had bilaterally PXF and 23.3% had PXF unilaterally. Among the bilateral PXF patients, 22 patients were pseudophakic in the other eye.

Presentation of PXF is usually unilateral to start with and progress towards bilaterality as the age advances.[4] Moderate unilateral PXF was more common rather than mild PXF in the present study.

Pseudoexfoliation presents commonly as a bilateral finding, but with variable severity in both eyes, and if presented unilaterally there is always a tendency towards bilaterality with age. Studies[67] indicate a higher percentage of subsequent progression to bilaterality, often with males being more frequently involved.

SchlotzerSchrehardt, Naumann [4] studied the ultra-structure of the contralateral eye in 5 pairs of donor eyes with unilateral PXS. They showed "Ultra structural" alterations in anterior segment tissues of all the eyes and concluded that basically PXS is a bilateral disease with clinically marked asymmetry in its manifestations. The reasons for this marked asymmetry remains unknown.

Clinically unilateral involvement if often a precursor to bilateral involvement within 5-10 years after diagnosis.[4]

Severity of PXF

78.3% of patients had pseudoexfoliative material on the pupillary margins and on the lens capsule visible through undilated pupi indicating i.e moderate PXF.[56] 8.3% were diagnosd after pupillary dilatation i.e mild PXF. Unless careful post-mydriatic slit lamp examination of the anterior segment is carried out, 1/4th of the PXF cases get un-noticed and end up for surgery as uncomplicated cataract. This is of

great importance when operating in a camp set up in large numbers. This is in concurrence with the study by Ritch, Schlotzer Scherhardt[69] who stated that deposits of PXF material on the iris sphincter and pupillary margin are seen in 32-94% of the patients. Thus next to the lens, PXF material is most prominent at the pupillary border and is a consistent clinical finding. 13.3% patients in this study had severe pseudoexfoliation, with deposits on the corneal endothelium and on the trabecular meshwork.

Intraocular pressure in PXF

In the present study, 6 (10%) patients had a pre-operative IOP of <10mm Hg and 54 (90%) had an IOP <21mm Hg. We have excluded patients who had any form of glaucoma.

In patients with pseudoexfoliation syndrome, 20% have glaucoma and increased IOP at the time of diagnosis. Patients who have pseudoexfoliation syndrome but not glaucoma should be considered vulnerable to glaucoma, because 15% of such patients develop increased IOP within 10 years. This underscores the need for careful follow-up in patients who have pseudoexfoliation syndrome. Pseudoexfoliation syndrome accounts for 15-20% of cases of open angle glaucoma. The present study is in concurrence with this finding.

Importance of AC depth

8 (13.3%) patients had shallow anterior chamber and 2 (3.3%) had variable depth of anterior chamber as per Van Herrick's grading preoperatively. Bartholomew stated that there was no significant difference in the depth of AC with or without PXF.[61] Forsius et al[62], also confirmed the same. If angle closure developed in association with PXF, some other mechanism plays a role as per Herbst[63] and Dark.[62]

In studies of patients with Pseudoexfoliation syndrome, occludable angles were noted in 9-18% of patients (Bruce shields 1999, fourth edition). Ritch, Schlotzer-Scherhardt[69] (2001) noted 23% of patients with Pseudoexfoliation syndrome and glaucoma to have grade 2 or narrow angles.

Wishart et al[70] (1985) noted 32% of patients in their study to have narrow angles.

According to recent literature, asymmetry of the AC depth rather than peripheral anterior chamber depth is a utmost importance to predict intraoperative zonular fragility.[56] AC depth asymmetry can be accurately assessed by IOL master or optical biometry.

However, we did not have means to measure the anterior chamber asymmetry quantitatively, no correlation could be derived between AC depth by Van Herricks and any complications during surgery in the study patients.

Quantitative assessment of AC asymmetry in all patients with PXF helps to assess zonular instability preoperatively.

Angle characteristics in pseudoexfoliation

81.7% of them had open angles with grade 3 and grade 4 as per Shaffer's classification, while 18.3% had occludable angle. 8.3% of the patients showed Sampolesi's line and 13.3% of them had PXF deposits on the trabecular meshwork. A total of 31 patients (51.7%) out of 60 patients showed pigment deposition over trabecular meshwork on gonioscopy.

Melanin dispersion post diagnostic mydriasis should always raise the suspicion of PXF syndrome, if other causes for pigment dispersion can be ruled out.[4]

Sunde[71] (1956) found flakes of Pseudoexfoliation material in the angle in 18.75% of the patients with pseudoexfoliative glaucoma. But Tarkkanen[24], in 1962, found Pseudoexfoliation material in the angle on gonioscopic examination in 46% of glaucomatous eyes and 50% of non glaucomatous eyes. Thus the two conditions can occur simultaneously or separately and the relation between them is not clear.

Lens characteristics in pseudoexfoliation syndrome

71.7% of patients in this study had nuclear cataract and 28.3% had mature cataract. and 1(1.7%) of them had subluxated lens preoperatively. Phacodonesis was seen in 3(5%) of the cases. Predominantly nuclear cataract has been associated with PXF.[4]

Seland et al[72] (1982) have reported a higher incidence of nuclear cataract in eyes with pseudoexfoliation syndrome with fewer cortical cataracts. Hietanen J. et al[73] have also reported nuclear cataract to be the predominant type of cataract in Pseudoexfoliation syndrome.

Futa R. Furnyoshi[74] (1989) reported an 8.4% incidence, while Moreno J., Duch S., Harara J[75] (1993) reported a 10.6% incidence of phacodonesis

Ritch R, Schlotze – Scherhardt[69] (2001) have also reported an increased incidence of nuclear cataract in Pseudoexfoliation syndrome.

The etiological association between nuclear cataract and PEX needs to be studied further.

Preoperative mydriasis

24 (40%) of patients had inadequate mydriasis (<5mm), and 19 (31.7 %) of the patients had average mydriasis (6-7mm) and 17 (28.3%) patients had adequate (>7mm) mydriasis. This is in concurrence with the following studies.

Among the patients who did not achieve sufficient mydriasis, few of them underwent iris manipulation in the form of microsphincetrotomies, and had irregular pupils with increased flare and anterior chamber cells postoperatively. There was no availability of iris dilating hooks or malyugin rings or CTRs due to economic constraints. Hence, most patients with unfavorable pupillary diameter underwent sphincterotomies. Lesser pupillary dilatation was seen more as the severity of PXF increases.

Pupillary dilatation has an inverse relationship with the grade of PXF and necessitating pupillary manipulation surgically. A total of 40 patients underwent sphincterotomy intraoperatively

Freyler H, Radax U[76] (1990) noted pupillary dilatation less than 4 mm in 19 of 32 patients with pseudoexfoliation syndrome who underwent cataract surgery.

Asano N, Schlotze – Scherhardt, Naumann[4] (1996) attributed poor mydriasis in Pseudoexfoliation syndrome to degenerative changes of sphincter and dilator muscle tissues and apparent involvement of the muscle cells in Pseudoexfoliation material fiber formation.

Repo L.P. et al[42] (1996) found degenerative changes in both the stromal tissue and in the muscular layer of iris and regarded this as one of the causes for miosis.

Alfaite et al[77] (1996) noticed significant insufficient mydriasis (p value < 0.001) in their study of 31 patients with Pseudoexfoliation syndrome. Reduction of stromal elasticity by accumulation of pseudoexfoliation material may also play a role in poor mydriasis.

Stanila A[78] (1996) also noted an increased incidence of insufficient pupil dilatation in the 10 patients with Pseudoexfoliation syndrome undergoing cataract surgery in their study.

Avramides S, Trainanidis P, Sakkias G[79] (1997) in their study of 84 patients with Pseudoexfoliation syndrome who underwent ECCE, noted that 61.90% of them had pupillary dilatation less than 5 mm.

Intraoperative management of poor mydriasis

Among the patients who did not achieve sufficient mydriasis, few of them underwent iris manipulation in the form of microsphincetrotomies. Anterior chamber was filled with viscoelastic and the puipllary margins were nibbled at 4 or 5 radial clocks hours with the vannas iris scissors.

Most patients with unfavorable pupillary diameter underwent sphincterotomies. These patients had irregular pupils with increased flare and anterior chamber cells postoperatively. As the severity of PXF increased, lesser pupillary dilatation was noted.

A total of 14 patients underwent sphincterotomy intraoperatively. Among these two were combined with synechiolysis. Two sphincter tears occurred on table.

Alfaite et al[77] (1996) in their study of 31 eyes of Pseudoexfoliation syndrome undergoing ECCE noted a statistically significant increase (p value < 0.01) in the need to perform sphincterotomies.

Kuchle et al[65] (2000) noted 3.4% of their 76 patients to require surgical Synechiolysis and/or mechanical dilatation of pupil intraoperatively.

Vickie Lee and Anthony Maloof[80] (2002) studied extensively on small pupils and their management during cataract surgery. They advocated that small pupils could be enlarged by prosthetic and non – prosthetic methods. Non – prosthetic techniques include visco-mydriasis, manual iris stretching and iris micro-sphincterotomies. Prosthetic techniques include iris hooks and use of pupil expansion devices.

Bayramlar et al[81] (2007) conducted a retrospective study in 225 eyes of 187 patients of which 99 eyes had Pseudoexfoliation syndrome. Pre-operative data collected were – Cataract maturity level, best corrected Visual acuity and Intraoperative posterior capsule complications. In this study, he interpreted that in MSICS, Pseudoexfoliation syndrome has an increased intraoperative posterior capsule complication rate that increases as the level of cataract maturity increases. Therefore, it is advisable to operate early on cataracts in patients with Pseudoexfoliation syndrome to have better results and prevent the compromised Zonular and posterior capsule changes.

Rhexis of around 5mm was achieved in 44 patients (53.08%) with average and sufficient mydriasis. In patients who had sphincterotomies, rhexis was not attempted for the fear of smaller capsulorrhexis and capsular phimosis later. The weaker zonular forces cannot counteract the centripetal forces of the anterior capsular contraction and

leads to phimosis later. Hence an appropriate sized capsulorrhexis and a thorough anterior capsular wash not leaving behind any cortical fibres or capsular sheets is extremely essential.[49, 50]

Incidence of intra-operative complications

44 (73.3%) patients underwent uneventful cataract extraction in the presence of pseudoexfoliation, while 16 of them had manipulations like iris microsphincterotomies, synechiolysis and manual anterior vitrectomy. Hence, if we exclude microsphincterotomies in small pupils (n = 6, mydriasis of 4mm or lesser) as it was planned before surgery in patients with insufficient mydriasis, 10 pts of inadequate/average mydriasis underwent iris manipulation. 2 patients had vitreous loss following posterior capsular rupture and zonular dialysis intra-operatively. So 10 patients needed appropriate (unplanned) surgical intervention decided during the intra-operative procedure.

The study of eventful surgeries went as follow:

Zonular dialysis as noted in 6 (10%) eyes and 1 eyes had subluxated lens preoperatively, and 3 patient had complete zonular dehiscence and inability to place IOL during surgery.

In 1 patient ACIOL was placed, 1 patiens ended up being aphakic, and the rest 8 (13.3%) had the IOL placement in the sulcus. Posterior capsular rupture encountered in 4 patients. Vitreous loss in a total of 3 patients and IOL was placed in sulcus or anterior chamber in the patients following anterior vitrectomy. Severe grade of pesudoexfoliation patients had insufficient mydriasis (53.74%), 17% had zonular dialysis intra operatively, 6 eyes had preoperative subluxated lens.

Intraoperative zonular dialysis could not be attributed to the severity of PXF. Patients with moderate and mild PXF also had complications like average mydriasis and pre-operative zonular dialysis, but perhaps due to iris manipulations, and sulcus placement of IOL, they ended up with uneventful surgery. Vitreous loss occurred in 3 patients. 4 of them had posterior capsular tear during cortical wash and nucleus prolapse, and 2 patients had capsular bag dialysis. The rate of vitreous loss in those with PXF was 3.3% compared with 0.92% in those without PXF. Hospital records were reviewed for major complications like posterior capsular rupture, vitreous loss and aphakia among patients undergoing cataract surgery without any predisposing risk factors and rate of 0.92% vitreous loss was seen. All these patients were carefully followed up in their postoperative period, and the findings noted.

Immediate Postoperative Period

Day 1

41 (68.3%) patients had clear cornea on next postoperative day, while 19 (31.7%) had corneal edema and 21 (35%) had striate keratopathy. Out of the 19 patients with corneal edema, 14 of them had additional surgical manupulations, leading to the suspicion of the preoperative endothelial decompensation. Decompensate corneal endothelium is vulnerable to the variations in IOP during surgery and can cause corneal edema next postoperative day.

Patients who underwent manual vitrectomy and iris manipulations had significant aqueous flare and cells in the postoperative period. When the grade of Anterior reaction was assessed in postoperative clear cornea, 16 (26%) grade 2+ reaction whereas 6 (10%) had grade 3+ reaction without any intraoperative special measures which probably could be attributed to PXF matter per se and due to blood

aqueous barrier breakdown. These patients were treated intensely with topical antibiotic steroids; followed up again on day 8, 1 month and 3 months later.

Mean post op IOP on post-op day 1 was noted to be 16.2 mmHg with a SD of 3.1 mmHg.

Day 8

Mean IOP on day 8 fell from mean on 16.2 on day 1 to a mean of 13.8 mmHg with SD of 2.1 mmHg indicating that IOP falls to preoperative range within 1 week.

While most of the cornea became clear by day 8, 1 remained oedematous. AC reaction returned to normal range in all patients where AC reaction could be evaluated.

Intermediate postoperative period

1 month

98.3% had clear cornea and 1 patient had edematous cornea who had moderate grade PXF, normal intraocular pressure, and iris manipulation during surgery; preoperative corneal endothelial status of that eye not known.

42 (70%) of them had round regular reactive pupils and 18 (30%) had irregular pupils at the end of 1 month. Among 16 patients underwent iris manipulations, 1 patients had iridoialysis and 2 patients had peaking pupils.

IOL decentration was noticed in 12 patients on mydriasis. 2 patients had in the bag IOL and the rest had sulcus placement after can opener capsulotomy and / or after anterior manual vitrectomy. Long term study with large numbers in required to

study the IOL decentration after rhexis and in the bag IOL placement in an eye with PXF.

3 months

98.3% of patients had clear cornea and 1 patient continued to have corneal oedema. IOL decentration was noticed in 13 patients on mydriasis. Posterior capsular opacity was noted in 1 patient at the 3 months follow up. 3 patients were lost to follow up at the 3rd month.

CONCLUSION

PXS presents challenges that need meticulous preoperative planning and intraoperative alertness and care to ensure safe surgery and successful postoperative outcome.

Prevalence of pseudoexfoliation is more in older rural population. Increasing age has been found to be important risk factor associated with PXF.

The ocular changes predispose to structural changes that increase the risk of cataract surgery. Thorough preoperative evaluation allows for improved operative planning and prevention of expected complications. Intraoperatively, zonule-friendly techniques reduce risk of complications. CTR's allow for stabilization and centration of lens capsule, and the ability to implant IOL within the capsular bag.

Awareness of postoperative issue reduces the potential negative impact of these issues.

Inadequate mydriasis due to rigid pupils, zonular dialysis & severity of pseudoexfoliation, are the major risk factors in eyes with PXF which are known to cause intraoperative complications like posterior capsular tear, vitreous loss and capsular bag dialysis. Intraoperative manoeuvers like sphincterotomies and/or synechiolysis, anterior vitrectomy, and sulcus positioning of IOL, result in postoperative increased flare and cells and IOL decentration.

Early surgery can reduce complications related to zonular fragility. In addition, regular follow-up of patients after surgery is required to assess endothelial cell function, to monitor for glaucoma and to examine for IOL position and centration. It is noted that in rural patients, the second eye to be operated is ignored

and patient presents in the stage of complications. Hence, it is essential to advise, counsel and encourage the patients, upon discharge, to undergo cataract surgery in the other eye as early as possible.

All though cataract surgery in Pseudoexfoliation syndrome is challenging, if the surgeon is aware of the condition pre operatively and pays meticulous attention to the surgical technique, a good outcome can be expected.

SUMMARY

- A prospective longitudinal hospital based study was done on the patients with pseudoexfoliation undergoing cataract extraction at the dept. of ophthalmology in Shri BM Patil Medical College, Vijayapur.
- A total 60 patients with pseudoexfoliation syndrome fulfilling the inclusion criteria were included in the study. The preoperative risk factors like rigid pupils, grade of PXF, zonular weakness, and intraocular pressure were studied. The incidence of intra and postoperative complications like zonular dialysis, vitreous loss, posterior capsular rupture, vitreous loss, uveitis, pesudophakic bullous keratopathy, corneal endothelial decompensation and irregular pupils were noted and studied in detail.
- In this study, the prevalence of PXF in patients with cataract was 3.95%. Incidence of PXF increases as the age advances.
- 8 (13.3%) of them had severe degree of PXF, 47 (78.3%) had moderate grade of PXF.
- 43 (71.7 %) had nuclear cataract, 1(1.7%) had subluxation of lens , 3 (5%) had phacodonesis.
- 24 (40%) had insufficient mydriasis (4-5 mm) and 16 patients underwent iris manipulation during the surgical procedure owing to inadequate pupil size.
- 73.3% of the surgeries were uneventful whereas 23.3% required intraoperative surgical manipulations. 6.7% had Posterior capsular rupture, 3.3% had vitreous loss.
- PCIOL was placed in 58 patients (50 in the bag and 8 in the sulcus), ACIOL in 1 patient and 1 patient was left aphakic.

- Postoperatively day 1, edematous cornea was seen in 19(31.7%) patients, striate keratopathy in 21(35%) patients which cleared up by day 8 in all patients except in 1.
- At the end of 1 month, 1 patient had endothelial decompensation. Irregular pupil was seen in 18 (30%) patients. IOL decentration was seen in 12 (20%) patients.
- Presence of pseudoexfoliation poses a threat to the cataract surgery and its documentation and a preoperative work up to take sufficient measures during surgery can cut down the incidence of complications and the best results can be achieved.

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ANNEXURES

ETHICAL CLEARANCE CERTIFICATE

B.L.D.E.UNIVERSITY'S
SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR – 586103
INSTITUTIONAL ETHICAL COMMITTEE

No/58/2015
20/11/15

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 17-11-2015 at 03 pm scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected and revised version synopsis of the Thesis has accorded Ethical Clearance.

Title "Clinical study of intra operative & post operative complications of cataract surgery in patients with pseudoexfoliation"

Name of P.G. Student : Dr. Dishitha. P. Rathod
Dept of Ophthalmology.

Name of Guide/Co-investigator : Dr Vallabha. K.
Prof & HOD, Ophthalmology

DR.TEJASWINI VALLABHA
CHAIRMAN
CHAIRMAN
Institutional Ethical Committee
BLDEU's Shri B.M. Patil
Medical College,BIJAPUR-586103.

Following documents were placed before E.C. for Scrutinization
1)Copy of Synopsis/Research Project
2)Copy of informed consent form.
3)Any other relevant documents.

CONSENT FORM

SAMPLE INFORMED CONSENT FORM:

TITLE OF THE PROJECT	:	CLINICAL STUDY OF INTRA OPERATIVE AND POST OPERATIVE COMPLICATIONS OF CATARACT SURGERY IN PATIENTS WITH PSEUDOEXFOLIATION
PG GUIDE	:	**DR.VALLABHA.K** **M.S, DOMS** PROFESSOR AND HOD DEPARTMENT OF OPHTHALMOLOGY B.L.D.E.U'S, SHRI B.M.PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, BIJAPUR, KARNATAKA
PRINCIPAL INVESTIGATOR	:	**DR. DISHITHA. P. RATHOD**

PURPOSE OF RESEARCH:

I have been informed that this study will help to find (if any) the intra operative and post operative complications of cataract surgery in patients with pseudoexfoliation. I have been explained about the reason for doing this study and selecting me/my ward as a subject for this study. I have also been given free choice for either being included or not in the study.

PROCEDURE:

I will be subjected to detailed history and systemic and ocular examination including Visual Acuity (by Snellen's Chart), detailed Slit Lamp Examination, Intraocular pressure by Applanation tonometry, Lacrimal Patency Test, Biometry and Goniascopy. I will then be subjected to investigations and management.

RISK AND DISCOMFORTS:

I understand that this study will help to find and document the intra operative and post operative complications of cataract surgery in patients with pseudoexfoliation and will not cause any discomfort. It will not involve any risk to my health.

BENEFITS:

I understand that my participation in the study will help to find and document the intra operative and post operative complications of cataract surgery in patients with pseudoexfoliation.

CONFIDENTIALITY:

I understand that medical information produced by this study will become part of institutional records and will be subject to the confidentiality and privacy regulation of the said institute. Information of a sensitive personal nature will not be a part of medical record, but will be stored in investigator's research file and identified only by a code number. The code key connecting name two numbers will be kept in a separate secured location.

If the data to be used for publication in the medical literature and for teaching purpose no names will be used and other identities such as photographs, audio and video tapes will be used only with my special written permission. I understand I may see the photographs and the video tapes and have the audio tapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study to **Dr. DISHITHA. P. RATHOD** in the Department of Ophthalmology who will be available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation. If during the study or later, I wish to discuss my participation in all concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me. A copy of this consent form will be given to me to keep for careful reading.

REFUSAL FOR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital. I also understand that **Dr. DISHITHA. P. RATHOD** may terminate my participation in the study at any time after he has explained the reasons for doing so.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me. But, no further compensation would be provided by the hospital. I understand that by my agreements to participate in this study and not waiving any of my legal rights.

I have explained to _____the purpose of the research, the procedures required and the possible risks to the best of my ability.

_____ _____

Dr. **DISHITHA. P. RATHOD** Date

(Investigator)

STUDY SUBJECT CONSENT STATEMENT:

I confirm that **Dr. DISHITHA. P. RATHOD** has explained to me the purpose of research, the study procedure, that I will undergo and the possible discomforts as well as benefits that I may experience in my own language. I have been explained all the above in detail in my own language and I understand the same. Therefore I agree to give consent to participate as a subject in this research project.

_____ _____

(Participant) Date

_____ _____

(Witness to signature) Date

PROFORMA

TITLE: "CLINICAL STUDY OF INTRA OPERATIVE AND POST OPERATIVE COMPLICATIONS OF CATARACT SURGERY IN PATIENTS WITH PSEUDOEXFOLIATION"

PATIENT DETAILS

Name: IP. No:

Age: Sex :

Address:

Occupation:

Income:

1. Chief complaints
2. History of presenting illness: Patient was apparently alright _____earlier then

H/o diminution of vision	Yes/ No
H/o pain	Yes/ No
H/o redness	Yes/No
H/o watering	Yes/No
H/o photophobia	Yes/No
H/o foreign body sensation	Yes/No

Other complaints

3. Ocular history:
4. Past history:
5. Family history:
6. Personal history:

General physical examination:

a) Pulse

b) B.P.

c) Respiratory rate

Ocular examination:

- Head posture:
- Facial symmetry:
- Ocular posture:

	Right eye	Left eye
➢ Visual acquity:		
➢ Eyebrows:		
➢ Eyelids:		
➢ Lacrimal apparatus:		
➢ Eyeball:		
Size		
Position		
Movements		
➢ Conjunctiva:		
➢ Cornea:		
➢ Sclera:		
➢ Anterior chamber:		
➢ Iris:		
➢ Pupil:		
➢ Lens:		
➢ Fundus:		
➢		
➢ IOP:		
➢ Biometry:		

Diagnosis:

INTRAOPERATIVE COMPLICATIONS

PARAMETERS	
PXF grade	
Mean Pupil Diameter	
Intra op manipulation	
Nucleus delivery	
Iris Atony	
Posterior capsular tear with/without vitreous loss	
Zonular Dehiscence	
Sulcus IOL	
Anterior Chamber IOL	
Intra operative Posterior Capsular plaque	
Any other	

POST OPERATIVE COMPLICATIONS

INTRA OP COMPLICATIONS

PARAMETERS	
Subluxation of lens	
Posterior dislocation of lens	
Posterior capsule rent with or without vitreous loss	
Nucleus drop	
Excessive choroidal bleeding	
Failure to implant IOL in the bag	
Damage to IOL – scratches on optic or breaking of haptic	

IMMEDIATE POST OP COMPLICATIONS

PARAMETERS	1st post op day	8th post op day
IOP		
Corneal Oedema		
SK		
Pupil		
AC Cells		
AC Flare		
Hyphema		
Fibrin in A/C		
Vision		

INTERMEDIATE POST OP COMPLICATIONS

PARAMETERS	POST OP 1 MONTH	POST OP 3 MONTHS
Cornea		
Uveitis		
Endophthalmitis		
Retinal Detachment		
Cystiod Macular Oedema		
Posterior Capsular Opacity		
Decentration of IOL		
Vision		

KEY TO MASTER CHART

Sr No.	– Serial number
IP no.	– In Patient number
M	– Male
F	– Female
WNL	– Within normal limits
RRR	– Round, Regular, Reactive
RR	– Round, Regular
PXF	– Pseudoexfoliation
NS	– Nuclear Sclerosis
LE	– Left Eye
RE	– Right Eye
CF-CF	– Counting finger close to face
PH	– Pin Hole
POD	– Post operative day
R	– Right
L	– Left
PL	– Perception of light
PR	– Perception of rays
PCO	– Posterior capsular opacity

IOP	– Intra ocular pressure
SMC	– Senile Mature Cataract
PD	– Phacodonesis
Sub	- Subluxated
SK	– Striate Keratopthy
A/C	– Anterior Chamber
VAR	– Variable
SHW	– Shallow
O	– Open
Occ	– Occludable
N	– Normal
PS	– Posterior Synechiae
SLG	– Sluggish
RIG	– Rigid
MOD	– Moderate
SEV	– Severe
MLD	– Mild
PIG	– Pigmentation
SL	– Sampolesi Line
FG	– Faint Glow

NG	– No Glow
MS	– Multiple Sphincterotomies
SY	– Synechiolysis
ST	– Sphincter Tear
IP	– Iris Prolapse
V	– Vectis
ZD	– Zonular Dehiscence
INT	– Intact
PC	– Posterior Capsule
PCR	– Posterior Capsular Rent
Sul	– Sulcus
I,R	– Irregular, Reactive
P	– Peaking
AB	– Air Bubble
A	– Aphakia