

**“COMPARISON OF PHACO-NUCLEOTOMY TECHNIQUES IN
THE MANAGEMENT OF PSEUDOEXFOLIATION
SYNDROME”**

By

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IN
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Under the Guidance of
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APRIL - 2012

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LIST OF ABBREVIATIONS USED

XFS	»	Pseudoexfoliation syndrome
PEX	»	Pseudoexfoliation
IOP	»	Intraocular Pressure
CTR	»	Capsular Tension Ring
CTS	»	Capsular Tension Segment
ZD	»	Zonular dehiscence
PCR	»	Posterior capsular rent
VL	»	Vitreous loss
POAG	»	Primary Open Angle Glaucoma
SMC	»	Senile Mature Cataract
SIMC	»	Senile Immature Cataract
SHMC	»	Senile Hyper-mature Cataract

ABSTRACT

BACKGROUND

Pseudoexfoliation syndrome is a common clinically important systemic condition characterized by the pathological production and accumulation of an abnormal fibrillar extracellular material in many intraocular and extra- ocular tissues. Many studies have shown that Pseudoexfoliation syndrome patients have higher rates of intraoperative complications during cataract surgery compared to the patients without it.

METHODS

It is a hospital based prospective study of 90 patients with cataract and Pseudoexfoliation syndrome attending RL Jalappa Hospital and research center ,Tamaka, Kolar.

OBJECTIVES

To compare Phaco-chop and Divide and Conquer techniques of phacoemulsification, in the management of pseudoexfoliation syndrome in terms of intraoperative complications.

RESULTS

The average age of patients in the study was 61.7 years with a male predominance with equal incidence of unilateral and bilateral involvement. Intra operative complications noted in Vertical chopping technique was only pupil constriction in 6.7% , no other complications were seen in this technique, whereas in horizontal chopping , 13.3% had pupil constriction , 6.7% had difficulty in chopping, 3.3% had zonular dehiscence and 3.3% had PC Rent .

And in divide and conquer technique 16.7% had pupil constriction, 10% had difficulty in trenching, 3.3% had PC Rent. 97.8% of the patients were implanted with intraocular lens after employment of various surgical modifications.

INTERPRETATION & CONCLUSION

Though Phacoemulsification surgery in eyes with Pseudoexfoliation syndrome is associated with intraoperative complications, vertical chopping technique scores over horizontal chopping and divide and conquer technique of phacoemulsification with good surgical outcome because of less complications.

KEYWORDS

Pseudoexfoliation syndrome; Phacoemulsification; Intraoperative Complications; Inadequate mydriasis; Intraocular Pressure; Glaucoma; Zonular dehiscence; Posterior capsular rent; Vitreous Loss.

TABLE OF CONTENTS

Sl.NO	Particulars	Page NO
1	INTRODUCTION	1-5
2	AIMS AND OBJECTIVES	6
3	REVIEW OF LITERATURE	7-30
4	MATERIALS AND METHODS	31-38
5	OBSERVATION AND RESULTS	39-52
6	DISCUSSION	53-59
7	CONCLUSION	60
8	SUMMARY	61-62
9	BIBLIOGRAPHY	63-69
10	ANNEXURES	70-73

LIST OF TABLES

Table No	Particulars	Page NO
1	AGE DISTRIBUTION ON PATIENTS WITH PSEUDOEXFOLIATION SYNDROME	39
2	SEX DISTRIBUTION IN PSEUDOEXFOLIATION SYNDROME	40
3	LATERALTY IN EYES WITH PSEUDOEXFOLIATION SYNDROME	41
4	ANGLE CONFIGURATION IN PSEUDOEXFOLIATION SYNDROME	42
5	COMPARISON OF PRE AND POST PUPILARY DILATATION SIZE	43
6	COMPARISON OF PUPIL IN BOTH THE GROUPS OF PATIENTS	44
7	COMPARISON OF TYPE OF CATARACT IN BOTH THE GROUPS	45
8	COMPARISON OF COMPLICATIONS IN BOTH THE GROUPS OF PATIENTS	46
9	COMPARISON OF BASIC AND CLINICAL VARIABLES IN THREE GROUPS OF PATIENTS	47
10	COMPARISON OF TYPE OF CATARACT IN THREE GROUPS OF PATIENTS	50
11	COMPARISON OF COMPLICATIONS IN THREE GROUPS OF PATIENTS	51
12	SURGICAL MODIFICATIONS IN PATIENTS WITH PSEUDOEXFOLIATION SYNDROME	52

LIST OF FIGURES

Table No	Particulars	Page NO
1	STAGES OF PSEUDOEXFOLIATION SYNDROME	12
2	AGE DISTRIBUTION ON PATIENTS WITH PSEUDOEXFOLIATION SYNDROME	39
3	SEX DISTRIBUTION IN PSEUDOEXFOLIATION SYNDROME	40
4	LATERALTY IN EYES WITH PSEUDOEXFOLIATION SYNDROME	41
5	ANGLE CONFIGURATION IN PSEUDOEXFOLIATION SYNDROME	42
6	COMPARISON OF PRE AND POST PUPILARY DILATATION SIZE	43
7	COMPARISON OF PUPIL IN BOTH THE GROUPS OF PATIENTS	44
8	COMPARISON OF TYPE OF CATARACT IN BOTH THE GROUPS	45
9	COMPARISON OF COMPLICATIONS IN BOTH THE GROUPS OF PATIENTS	46
10	COMPARISON OF BASIC AND CLINICAL VARIABLES IN THREE GROUPS OF PATIENTS	48-49
11	COMPARISON OF TYPE OF CATARACT IN THREE GROUPS OF PATIENTS	50
12	COMPARISON OF COMPLICATIONS IN THREE GROUPS OF PATIENTS	51
13	SURGICAL MODIFICATIONS IN PATIENTS WITH PSEUDOEXFOLIATION SYNDROME	52

LIST OF PHOTOGRAPHS

Table No	Photographs	Page No
1	PSEUDOEXFOLIATION MATERIAL AT THE PUPILLARY MARGIN AND ANTERIOR SURFACE OF LENS CAPSULE WITH UNDILATED PUPIL.	74
2	ZONE OF PSEUDOEXFOLIATION MATERIAL ON THE ANTERIOR CAPSULE OF LENS AFTER PUPILLARY DILATION.	74
3	PSEUDOEXFOLIATION MATERIAL AT THE PUPILLARY MARGIN	75
4	HISTOPATHOLOGY OF PSEUDOEXFOLIATION MATERIAL ON THE ANTERIOR LENS CAPSULE.	75

INTRODUCTION

Pseudoexfoliation syndrome is an age related disease, and is frequently associated with cataract. 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. These morphological alterations form the basis of clinical classification into:

- 1.Preclinical stage (clinically invisible)
- 2.Suspected stage (precapsular layer)
3. Mini Pseudoexfoliation(early ruboff of PEX material from the anterior lens capsule, typically in the superonasal quadrant)
- 4.Classical PEX

The most consistent diagnostic feature is three distinct zones of pseudoexfoliation material seen on the lens capsule after full dilatation:

1. A translucent, central disc with occasional curled edges.
2. Middle clear zone corresponding to probable contact with the moving iris.
3. 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.)

Additional subtle clinical signs that help in early diagnosis are loss of pigment from peri-pupillary area producing transillumination defects, insufficient mydriasis, and pigment dispersion into anterior chamber after

mydriasis, deposition of melanin over trabecular meshwork and Schwalbe's line.

The existence of posterior synechiae without any other cause and haemorrhage in the iris stroma after mydriasis are also suggestive of pseudoexfoliation syndrome.

Zonular instability , which may lead to phakodonesis and lens subluxation , results from three different mechanisms:

1. Initially , active production of PEX material by the pre-equatorial lens epithelium with proliferation through the capsular surface disrupts the zonular lamella and their insertion into the anterior lens capsule.
2. The zonules are separated from their firm origin and anchored in the basement membrane of the nonpigmented ciliary epithelium by locally produced , intercalating PEX fibres.
3. PEX material contains proteolytic enzymes facilitating zonular disintegration.

Pre operative anterior chamber depth is a major prognostic indicator for zonular weakness.

The increased incidence of open angle glaucoma in PEX patients is due to mechanical blockage of trabecular meshwork by PEX material with active PEX accumulation within the trabecular cells causing secondary degeneration. 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.

Pseudoexfoliation syndrome has a strong familial association and recently, the lysyl oxidase-like 1 gene has been strongly associated with this disorder.

This gene is involved in the synthesis and maintenance of elastic fibers and therefore has a strong biological rationale for being involved in this disorder. However, the exact relationship between lysyl oxidase- like 1 polymorphisms and the development of Pseudoexfoliation syndrome has not been elucidated. Also, the value of genetic testing for this disorder has not been validated. XFS is an important risk factor for glaucoma and lysyl oxidase-like 1 polymorphisms are strongly associated with XFS.

Making the diagnosis often requires a careful slit- lamp examination after pupillary dilatation and pseudoexfoliation syndrome frequently goes undiagnosed leading to unexpected problems in management and during surgery. Due to the involvement of virtually all structures by pseudoexfoliation material, patients have a significantly greater risk for a variety of complications during cataract surgery. Poor mydriasis, pigment dispersion, combined with phacodonesis and zonular dialysis predisposes to capsular rupture and vitreous loss. 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.

Pseudoexfoliation syndrome should not be considered a harmless anomaly of the anterior segment but a potential catastrophic disease.

MANIFESTATIONS OF PSEUDOEXFOLIATION SYNDROME		
TISSUE INVOLVED		CLINICAL SIGNS
Ocular	lens	Zonular instability, Phacodonesis, Subluxation, Nuclear Cataract.
	Zonules	Zonular instability.
	Iris	Vasculopathy: Blood-aqueous barrier defect, pseudo-uveitis, anterior chamber hypoxia, capillary hemorrhage, iris rigidity, posterior synechiae, poor mydriasis, Asymmetric papillary reaction, stromal / pigment epithelial atrophy, melanin release.
	Trabecular meshwork	Increased resistance to Aqueous outflow, Elevated intra-ocular pressure.
	Cornea	Reduced endothelial cell count. Corneal decompensation Corneal endothelial proliferation.
Extra-ocular	Skin, Extra-ocular muscles, As yet unknown. Heart, Liver,Lung, Kidney, Meninges	

**OCCURRENCE OF COMPLICATIONS OF
PSEUDOEXFOLIATION SYNDROME**

Spontaneous		Ocular hypertension / glaucoma, Lens Subluxation, Nuclear cataract, Pseudo-uveitis, Corneal decompensation
Pre-operative (by medication)	Mydriatics	Poor dilatation, Melanin dispersion, Iris hemorrhage.
	Miotics	Posterior synechiae, Pupillary block, Ciliary block.
Intra-operative	Phaco emulsification	Poor mydriasis, Zonular dehiscence, PC Rent, Vitreous loss.

Phacoemulsification is the preferred method of cataract surgery in these patients. But presence of pseudoexfoliation makes surgery challenging for the phaco surgeon, as these patients are more prone for intraoperative complications such as zonular dialysis, posterior capsule rent and vitreous loss as a consequence of weak insufficient zonules. These complications can be prevented by modified surgical techniques.

AIMS AND OBJECTIVES:

To compare Phaco-chop and Divide and Conquer techniques of phacoemulsification , in pseudoexfoliation syndrome in terms of intraoperative complications.

REVIEW OF LITERATURE:

In 1917, **Lindberg**¹ described grayish or bluish flakes of material on the pupillary border in some patients with glaucoma. **Vogt**² later hypothesized that this material represented degenerative changes of the lens capsule followed by secondary desquamation and proposed the term senile exfoliation of the lens capsule. **Busacca**³ argued that the exfoliative material represented deposition of material formed elsewhere in the eye rather than degenerative changes of the lens capsule.

Dvorak-Theobald⁴ subsequently showed that exfoliative material differed histochemically from lens capsule and, to differentiate this condition from true exfoliation of the lens capsule secondary to infrared exposure, suggested the term pseudoexfoliation of the lens capsule. Subsequent electron microscopic studies by **Ashton**⁵ and associates and **Bertelsen**⁶ and coworkers indicate that the anterior lens capsule was directly affected in this disorder. Bertelsen and associates suggest that pre-equatorial lens epithelial cells produced the abnormal fibrillar substance and recommend the term fibrillographia epitheliocapsularis. **Eagle and colleagues**⁷, who believe that the material represented abnormal basement membrane secretions, have called this condition basement membrane exfoliation syndrome.

The terms exfoliation syndrome and pseudoexfoliation syndrome are now most commonly used to designate this disorder and are used interchangeably in current literature. However, since recent ultrastructural studies indicate that the material on the lens capsule is derived, at least in part, from the lens, it is proposed that the disorder be called exfoliation syndrome (XFS).⁸⁻¹⁰

EPIDEMIOLOGY

Pseudoexfoliation Syndrome is of global distribution. The reported prevalence of Pseudoexfoliation Syndrome both with and without glaucoma has varied widely. This reflects a combination of true difference due to racial, ethnic or as yet unknown factors; the clinical criteria used to detect early stages and/or more subtle changes, the method and thoroughness of examination and awareness of the examiner. In US population, the **Framingham Eye Study**¹¹ revealed the overall prevalence of Pseudoexfoliation syndrome to be 0.6% in 52 – 64 years old, rising to 5% in 75 – 85 years old. In India, the prevalence rates reported were 1.88% **Sood N.N.**¹² (1965), 7.4% **Lamba and Giridhar**¹³ (1984). The prevalence rate in south India is 3.8% **Aravind H et al**¹⁴ (2003) . 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.

The prevalence increases with age, the disease most commonly manifesting between 60–70 years. But Pseudoexfoliation Syndrome might well be a condition that starts in mid-adulthood but becomes frankly manifest only in later years. Sex ratio reports are conflicting.

A hereditary transmission of Pseudoexfoliation Syndrome is not yet clarified. **Tarkkanen**¹⁵ (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 al¹⁶ 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). Asian populations including Indians reported associations with LOXL1 and XFS.

R.R. Allingham et al¹⁷ (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.

It is now known that Pseudoexfoliation Syndrome is essentially a bilateral condition and unilateral cases only represent an earlier period in the natural history of the condition. When only one eye is involved clinically, the other eye often has abnormal aqueous humour dynamics or glaucomatous damage.

CLINICAL FEATURES

1. OCULAR MANIFESTATIONS^{18, 19, 20, 21, 22, 23, 24}

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 2. 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 disc 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.

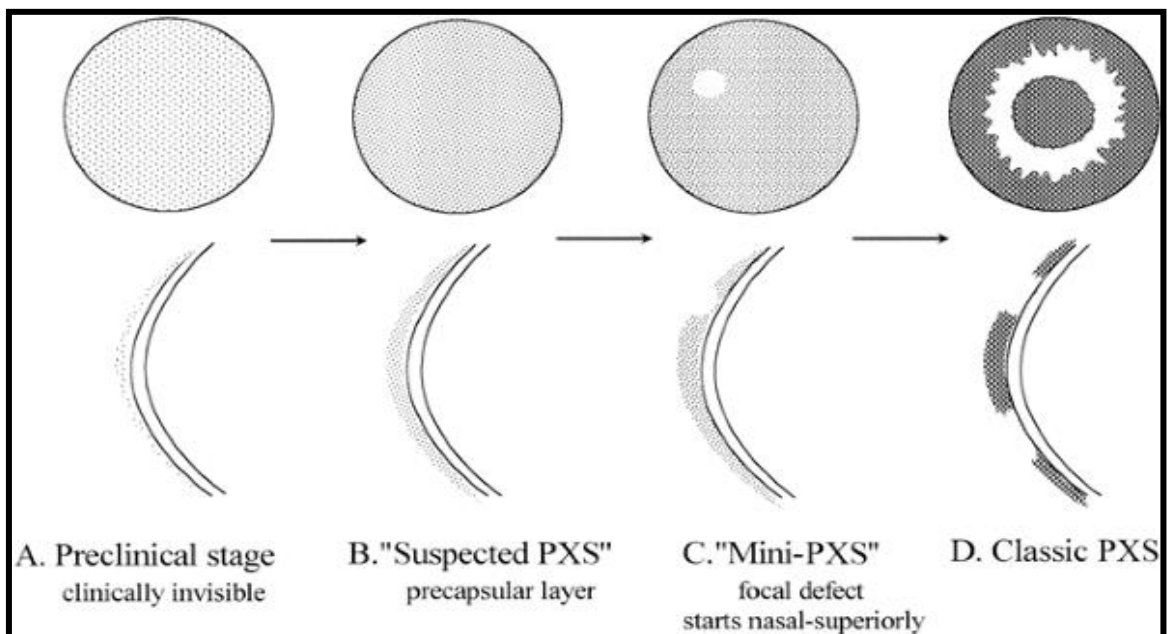
A homogeneous “ground glass” or “matte” appearance of the lens surface in one eye compared to the other may represent a very early (pre-capsular) stage. In a perhaps slightly later (pre-granular) stage, there may be very faint radiant non-granular striae on middle third of the anterior capsule behind 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 pupillary 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.

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.



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 is not seen to occur from 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 first are those behind the equator and those just anterior to the equator remain intact.

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.¹⁹ Inflammation after cataract extraction is more common and a transient fibrinoid reaction attributed to breakdown of Blood-aqueous barrier may occur²⁰.

Intra-stromal haemorrhage 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 pupillary 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.

c) CILLIARY BODY

The ciliary processes were examined clinically by **Mizuno and Muroi**²¹ 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 ^{22,23}:

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 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.

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.

e) ANGLE CHARACTERISTICS²²

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 root. Thereby, the localized iris bombe near the iris root 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 papillary 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.

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.

2. SYSTEMIC MANIFESTATIONS^{23, 25, 26}

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.

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, ciliary body and conjunctiva.

Schlotzer-Schrehardt et al²⁵ 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**²⁷ 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 microfibrils and exfoliation material.

Garner and Alexander²⁸ 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 al²⁹ 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**³⁰ in 1998 analyzed by electron microscopy the matrix of the pseudoexfoliation material and demonstrated in to be fibrillin positive fibers, supporting the elastic micro fibril theory of its production.

3. AMYLOID THEORY

Repo L.P. Naucharinen et al³¹ 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**³² described patients with both primary familial amyloidosis and exfoliation.

4. LYSOZOMAL THEORY

Mizuno et al³³ 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 lysosomal involvement.

Proteolytic enzymes present in lysosomes may facilitate granular disintegration.

Baba³⁴ 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 proteoglycans, 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 extracellular matrix synthesis, including the incorporation of the principle noncollagenous basement membrane components. Extensive labeling of exfoliation material for chondroitin sulphate suggests an over-production and abnormal production of glycosaminoglycans 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 keratan 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^{35, 36}, (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 glycosaminoglycans. 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 glycosaminoglycans forming the amorphous substance.

CATARACT SURGERY IN PSEUDOEXFOLIATION SYNDROME

Patients with Pseudoexfoliation Syndrome are much more prone to have complications at the time of cataract extraction. Eyes with Pseudoexfoliation Syndrome dilate less well and have greater incidence of capsular rupture, zonular dehiscence and vitreous loss. Pupillary diameter and zonular fragility have been suggested as the most important risk factors for capsular rupture and vitreous loss. The presence of phacodonesis has been related to poor mydriasis, cataract, and presence of glaucoma and trabecular pigmentation, all a reflection of the severity of involvement and should serve a warning sign. A shallow anterior chamber may indicate zonular instability.

Post-operatively, transient intra-ocular pressure elevations are common. Posterior capsular opacification is more common. Late postoperative decentration of intra-ocular lens and capsular bag are common, and is related to zonular weakness.

Capsular contraction syndrome if exaggerated, can lead to intra-ocular lens dislocation. Secondary cataract is more common because of aggravated blood-aqueous barrier breakdown.

Skuta G. L., Parrish R. K. et al³⁷ (1987) showed an increased incidence of zonular dialysis in patients with Pseudoexfoliation Syndrome during cataract surgery. They stated that pre-operative phacodonesis, anterior chamber depth asymmetry and excessive lens movement during anterior capsulotomy should alert to the presence of zonular dialysis.

Naumann G. O., Kuchle M. Schonherr U³⁸ (1989) noted a seven fold increase in vitreous loss in 72 patients with Pseudoexfoliation Syndrome undergoing cataract surgery.

Wang L., Yamasita R. et al³⁹ (1999) studied 26 eyes with Pseudoexfoliation Syndrome with specular microscopy and quantified the aqueous flare with laser flare cell meter. They showed that the corneal endothelial cell density was significantly decreased in eyes with Pseudoexfoliation Syndrome and an inverse correlation was shown with the flare. The authors concluded that a decrease in the endothelial cells may correlate with a disruption of blood-aqueous barrier.

Kuchle M, Naumann.H et al⁴⁰ (1997) emphasized the fact that pseudoexfoliation syndrome is frequently associated with impairment of

blood-aqueous barrier and thereby have higher frequency of secondary cataract post cataract surgery.

Lumme P. Lattikaanen L⁴¹ (1993) performed a prospective study of 351 patients undergoing cataract surgery. In their study the prevalence of Pseudoexfoliation Syndrome was more in patients greater than 70 years. Pseudoexfoliation Syndrome increased the risk on intra-operative complications either directly (rupture of zonules) or through poor dilation of pupil (rupture of posterior lens capsule). The occurrence of vitreous loss was four fold and the need to use anterior chamber intra-ocular lens was tenfold in these patients.

Moreno et al⁴² (2000) suggested irido-phacodonesis, poor dilatation and presence of glaucoma as the clinical factors related to capsular rupture during cataract surgery.

Freyler H. Radax U⁴³ (1994) compared Extra-capsular cataract surgery with phacoemulsification in 311 and 68 patients respectively.

Miosis and phacodonesis were reported as the primary risk factors for cataract surgery associated with Pseudoexfoliation Syndrome. Compared with extra-capsular cataract surgery, **phacoemulsification** had significantly fewer complications with regard to miosis but not phacodonesis. They advised applying a small iris retractor, hooks to stem the complications arising from miosis.

Stanila A⁴⁴ (1996) noted that out of 868 patients undergoing cataract surgery, 10% had Pseudoexfoliation Syndrome and these patients had an increased incidence of insufficient dilatation of pupil, posterior capsular tears,

Vitreous loss, increase in post-operative intra-ocular pressure and more frequent opacification of posterior capsule.

Kuchle et al⁴⁵ (2000) suggested that a shallow anterior chamber depth of less than 2.5 mm pre-operatively was indicative of zonular instability and should alert the surgeon of intra-operative complications.

Bayramlar et al⁴⁶ (2007), conducted a retrospective study in 225 eyes of 187 patients, of which 99 eyes had pseudoexfoliation syndrome. Preoperative data collected were cataract maturity level, best corrected visual acuity and intraoperative posterior capsule complications. In this study, he interpreted that in manual small incision cataract surgery, pseudoexfoliation syndrome has an increased intraoperative posterior capsule complication rate that increases as the level of cataract maturity increases and the preoperative visual acuity decreases.

Albert Galand MD, Michael Kuchle MD, Etienne Thchet MD⁴⁷ (2004) at a symposium held during the 21st congress of the ESCRS reviewed the pathophysiological alterations associated with pseudoexfoliation, the consequences of cataract surgery, and the considerations for surgical modifications and intraocular lens selection.

They stressed on poor mydriasis, a prominent feature of pseudoexfoliative eyes and its management by injection of high viscosity viscoelastic agent, also advocated use of iris hooks, either plastic or metallic as necessary. Dr. Hachet cautioned against performing sphincterotomy, which resulted in persistent dilatation and poor postoperative chemosis, he recommended against use of circular plastic dilator to push the pupil rim aside, also advocated on use of capsular tension rings.

Foldable intraocular lens is desirable to minimize the induction of blood-aqueous barrier breakdown and the accompanying increased risks for postoperative complications. Also hydrophobic acrylic and silicone are associated with a low rate of posterior capsular opacification, but hydrophobic acrylic has an additional advantage as it causes the least amount of capsular contraction. For haptics, overall, open loop haptics are probably preferred, and PMMA may be better than prolene. Dr Kuchle also discouraged the use of plate haptic design or accommodative intraocular lens in patients with pseudoexfoliation.

Vickie Lee and Anthony Maloof⁴⁸ (2002) stated that a CTR allows for the expansion and stabilization of the capsular bag by redistributing forces with the resulting tautness of bag providing counter-traction to facilitate cataract surgery and cortical aspiration.

This is extremely useful for moderate degrees (i.e. up to 5 hours) of zonular dialysis. The CTR can be inserted after the completion of capsulorrhexis but before hydrodissection.

Howard Fine⁴⁹ (2008) CTR will convert a high risk case into a routine case when there is compromised zonular integrity. CTR work because the ring diameter is larger than the capsule diameter so that there is centrifugal force on the capsular fornix and this distributes focal forces.

Any focal force on the capsule cannot be transmitted only to the adjacent zonules with an unzipping of the zonular apparatus – the ring makes that focal force distributed circumferentially to the entire zonular apparatus. In cases of advanced zonulopathy with overt subluxation of the capsular bag, the capsular tension segments (CTS) can be used instead of CTR.

The CTS is a 120° partial CTR that features an islet positioned within the capsulorrhexis that can receive an iris hook for support. Two CTS can be used to support a very loose bag. The CTS can also be used in eyes with anterior or posterior capsular tears. The CTS are also designed for suture sclera fixation, for long term capsular bag centration .

MANAGEMENT OF PSEUDOEXFOLIATION SYNDROME BY CATARACT SURGERY ^{50, 51, 52, 53, 54}

These are several important points to remember for cataract surgery in eyes with Pseudoexfoliation syndrome.

1. MAKING THE DIAGNOSIS

Limited pharmacological mydriasis can adversely affect the ability to make the diagnosis. Flaky deposits on the corneal endothelium is one, clue in assessing the condition. This material can be differentiated from true keratic precipitate by their bright white color and fluffy appearance. When differentiation is difficult, a one to two week course of topical steroids can aid in diagnosis, as keratic precipitates change in appearance or location or disappear with topical steroid use but have no effect on Pseudoexfoliation material

An unusually shallow anterior chamber depth from zonular instability can indicate Pseudoexfoliation especially if it is asymmetrical.

Even though a patient's cataract and symptomatic complaints are monocular, the contralateral eye may have subtle findings of Pseudoexfoliation which may not be seen in the planned surgical eye.

Even if Pseudoexfoliation material is not clinically visible on the corneal endothelium, the cell count may be significantly reduced and the cells that remain may not function well, hence additional endothelial protection including a “pseudoplastic” viscoelastic such as healon is advised.

2. MAXIMAL DILATATION OF PUPIL DURING SURGERY.

Poor mydriasis, a well known feature of Pseudoexfoliation syndrome can seriously hamper the surgeon’s view, additional pupillary dilatation may also be necessary. Several mechanical means can temporarily dilate the pupil during surgery.

These include flexible iris retractors, titanium iris retractors, flexible pupil dilating rings and rigid dilating rings. Pupil stretching maneuvers like sphincterotomies are an inexpensive and easier alternative. While these are effective, excessive inflammatory responses due to the compromised blood-aqueous barrier in these eyes are well documented. Further, the iris is more flaccid in Pseudoexfoliation syndrome and more likely to be inadvertently aspirated; mechanical means to augment mydriasis is to also keep the floppy iris margin away from the aspiration port or cannula. Care should be taken to avoid excessive iris trauma and over-inflation of the anterior chamber with viscoelastic, which can cause posterior pressure on the lens and can further damage the weakened zonules.

3. ENSURING ADEQUATE CAPSULORRHEXIS/CAPSULOTOMY.

Capsulorrhexis/capsulotomy creation is more difficult in these cases, as there is no counter-traction during tearing of the anterior lens capsule.

This can present as a star pattern of capsular folds radiating from your instrument when piercing the anterior lens capsule and as wrinkling and looseness of the capsule.

The solution, as described by Thomas Neuhann of Germany, is to provide counter-traction via the non-dominant hand using a chopper or other second instrument via the paracentesis, while using the dominant hand to perform the capsulorrhexis via the main incision. Because of the tendency for anterior capsular phimosis and further zonular stress, a large capsulorrhexis should be performed, at least 5.5 mm in diameter. Staining the capsule with indocyanine green or trypan blue is useful. The Pseudoexfoliation material has a higher affinity for indocyanine green stain than unaffected capsule.

4. ATTENTION TO PHACODONESIS WHILE PERFORMING CAPSULORRHEXIS/ CAPSULOTOMY

Weak zonules is one of the most notorious, common and significant problem faced by cataract surgeon in Pseudoexfoliation syndrome. The degree of weakening though highly variable appears to increase with apparently increasing amount of deposits. Dislocation of the nucleus into the vitreous cavity may occur even during routine hydrodissection. During capsulorrhexis or capsulotomy creation, diffuse zonular weakness or laxity may be sensed. Once this weakness is apparent, the risk of creating zonular dialysis is large. In such cases, flexible “iris” retractors can engage the capsulorrhexis margin and stabilize the loosened capsular bag.

5. MANAGEMENT OF ZONULAR DIALYSIS.

If a small or moderate zonular dehiscence occurs, a standard capsular tension ring can re-expand the capsular bag and redistribute the mechanical stresses evenly across the remaining zonules. The capsular tension ring (CTR) can be manually implanted into the fornix of the capsular bag or injected with the inserter device.

For a large zonular dehiscence, a suture-fixated, modified Cionni ring with one or two fixation eyelets will re-expand the capsular bag and secure the capsular bag or intraocular lens complex to the sclera wall.

6. CHOICE OF INTRAOCULAR LENS.

Capsular contraction is more likely since there is reduced zonular counter-traction against the centripetal forces of the remaining lens epithelial cells. Capsulorrhexis of 5mm or greater, and use of a capsular tension ring to reduce the risk of this complication is advisable. As capsular contraction is more common with silicone intraocular lens, another material is preferred.

An intraocular lens with a sharp posterior edge to reduce lens epithelial cell migration and subsequent posterior capsular opacification is recommended. Pseudoexfoliation syndrome adds to the challenges of cataract surgery. Some of these challenges are significant. With the use of dyes, capsule retractors and implant rings and meticulous attention to surgical technique, cataract surgery in Pseudoexfoliation syndrome may be safely performed.

MATERIALS AND METHODS

TITLE OF THE STUDY:

“Prospective Two Years Study of comparison of phaco-nucleotomy techniques in management of pseudoexfoliation syndrome”.

SOURCE OF DATA: Patients admitted with cataract and pseudoexfoliation at R.L.J. HOSPITAL AND RESEARCH CENTRE, TAMAKA, KOLAR attached to SRI DEVRAJ URS MEDICAL COLLEGE between November 2009 and May 2011 were prospectively analysed. Total number of 90 cases of acquired cataract fulfilling the selection criteria were included in the study after their informed consent.

SAMPLE SIZE:

A total number of 90 patients of cataract with pseudoexfoliation syndrome, were selected for the study . These patients were divided into two groups :

GROUP A: Phaco chop (60 cases)

- a) Vertical chop- 30 cases
- b) Horizontal chop-30 cases

GROUP B: Divide and Conquer(30 cases)

INCLUSION CRITERIA:

1. Patients undergoing Phacoemulsification cataract surgery with Pseudoexfoliation syndrome.
2. Patients with pseudoexfoliation syndrome as evidenced by pseudoexfoliation material on the pupillary margin and on the anterior surface of lens capsule.

3. Patients with senile cataracts – immature, mature, hypermature cataracts in pseudoexfoliation syndrome.

EXCLUSION CRITERIA:

1. Traumatic cataracts.
2. Complicated cataracts.
3. Subluxated lens without pseudoexfoliation syndrome.
4. Patients with senile cataracts – immature, mature, hypermature cataracts without pseudoexfoliation syndrome.
5. Those associated with raised intra ocular pressure or glaucoma.

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.
 - Phacodonesis or frank subluxation/dislocation of lens.
 - Measurement of pupil size before and after dilatation of pupil.
 - Pupillary reactions.
5. Tonometry using Schiottz 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:

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.

Grade	Angle width (degree)	configuration	Chance of closure	Structure visible on gonioscopy.
4	35-45	Wide open	Nil	From Schwalbe's line to ciliary 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 5% phenylephrine and tropicamide 0.8% drop was instilled every 5 minutes for 15 minutes interval.

8. This was followed by slit lamp examination for

- Measuring pupil size.
- 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 0.8% 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 flubiprofen was instilled three times one day before surgery and half hourly for two hours immediately before surgery.

The eye to be operated is painted, draped and prepared for surgery under aseptic precautions.

1. Local anesthesia, peribulbar block is given using 2% xylocaine mixed with 1500 units of hyaluronidase.
2. Universal wire speculum applied.
3. Superior rectus (bridle) suture is passed to fix the eye in downward gaze.
4. A small fornix based conjunctival flap is made, and sclera is exposed superotemporally.
5. Haemostasis is achieved by applying gentle and just adequate wet field cautery.
6. A self sealing 2.8mm sclero-corneal tunnel incision is made.
7. Side-port entry is made with the help of 1.5mm valvular corneal incision at 9⁰ clock position.

8. Anterior capsulotomy by continuous curvilinear capsulorrhexis of adequate size is done.
9. Hydrodissection is done to separate cortico-nuclear mass from the posterior capsule.
10. Depending on the degree of mydriasis the pupil was stretched mechanically or sphincterotomies were done, depending on the operating surgeon's discretion. Synechiolysis was done if required.
11. Phacoemulsification was performed following different nucleotomy techniques:

Divide and Conquer Technique

Divide and Conquer is the parent nucleofracture technique. The technique was developed to facilitate subdivision of the nucleus into small pieces so that they could be removed more efficiently .

Four basic steps are incorporated in divide and conquer technique; deep sculpting until a fracture is possible, nucleofractis of the nuclear rim and posterior plate of the nucleus, fracturing again and breaking away a wedge-shaped section of nuclear material for emulsification, and rotation or repositioning of the nucleus for further fracturing and emulsification, power used was 60-80% with vacuum up to 250mmhg and flow rate 22-25cc/min.

Phaco Chop (Horizontal Chop)

The phacoemulsification tip is initially buried in the direction of the center of the nucleus. The lens nucleus is held in position using relatively high vacuum, while the chopping instrument is passed under the distal edge of the anterior

capsulotomy and around the lens equator. The tip of the chopper is then drawn through the lens nucleus toward the phaco handpiece in the horizontal plane, cleaving the lens. The phaco tip and chopper are then separated laterally, breaking the nucleus into two pieces. The nucleus is then rotated 90 degrees, and the same procedure is performed on each of the lens halves. The nucleus is broken into four or more pieces, depending on the density of the lens (more pieces for denser lenses). The lens fragments are then removed and emulsified using power of 40-50% with vacuum upto 400mmhg and flow rate of 22-25cc/min.

Quick Chop (Vertical Chop)

Quick chop is a variant of the phaco chop technique in which the chopper is not passed horizontally around the lens equator, but rather enters the nucleus vertically near the center of the lens. The phaco tip is initially exposed, with the silicone sleeve withdrawn approximately 2.5 mm. The tip is buried into the center of the nucleus, and the nucleus is held in place with vacuum. Next, the chopper is placed slightly in front of the phaco tip, and the chopper tip is embedded as deeply as possible into the lens. Force is placed laterally and downward with the chopper to split the lens into two halves.

The nucleus is rotated, and a similar procedure is performed on each lens half. The benefits of this procedure are the good visualization of the chopper throughout, and the avoidance of proximity to the capsular bag, resulting in increased safety.

Cortical matter was removed by irrigation and aspiration.

Intraoperative complications in all the three nucleotomy techniques performed were noted.

12. Rigid Posterior chamber intraocular lens was placed in the capsular bag after extending the incision.
13. The viscoelastic was cleared from the anterior chamber.
14. Subconjunctival gentamycin and dexamethasone 0.5cc was given at the end of the procedure.
15. Pad and bandage applied.

Postoperatively all patients received a course of topical antibiotic and steroid eye drops second hourly for a week, followed by a tapering dose for 6 weeks along with Flurbiprofen eye drops 0.03% 3 times a day for 4 weeks. Systemic antibiotic Tab Ciprofloxacin 500mg was given for 5 days postoperatively. Tab Diclofenac stat was given in case the patient complained of pain.

OBSERVATION AND RESULTS

TABLE 1: COMPARISON OF AGE AND GENDER DISTRIBUTION

Age in years	Group A		Group B	
	No	%	No	%
48-50	6	10.0	2	6.7
51-60	24	40.0	12	40.0
61-70	26	43.3	16	53.3
71-80	3	5.0	0	0.0
81-90	1	1.7	0	0.0
Total	60	100.0	30	100.0
Mean $\pm$ SD	61.47 $\pm$ 7.11		61.17 $\pm$ 5.34	

Samples are age matched with $p=0.847$

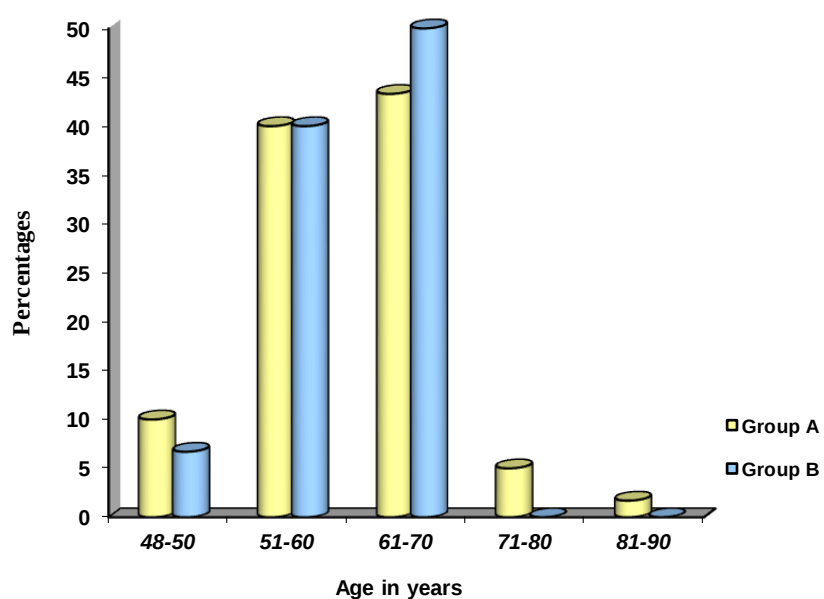
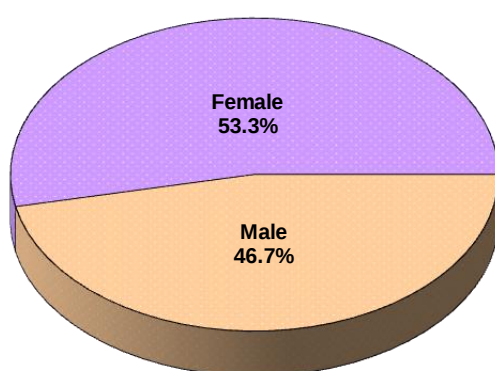


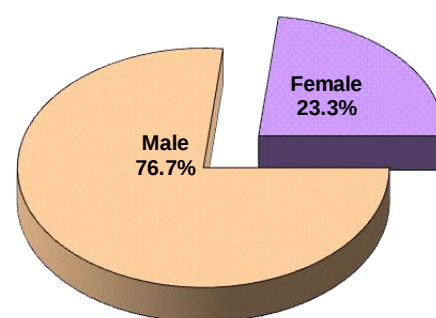
TABLE 2: GENDER DISTRIBUTION OF PATIENTS STUDIED

Gender	Group A		Group B	
	No	%	No	%
Male	28	46.7	23	76.7
Female	32	53.3	7	23.3
Total	60	100.0	30	100.0

P=0.007**



Group A



Group B

TABLE 3: LATERALITY IN EYES WITH PSEUDOEXFOLIATION
SYNDROME

LATERALITY	NUMBER OF PATIENTS	PERCENTAGE
Unilateral	45	50%
Bilateral	45	50%
Total	90	100%

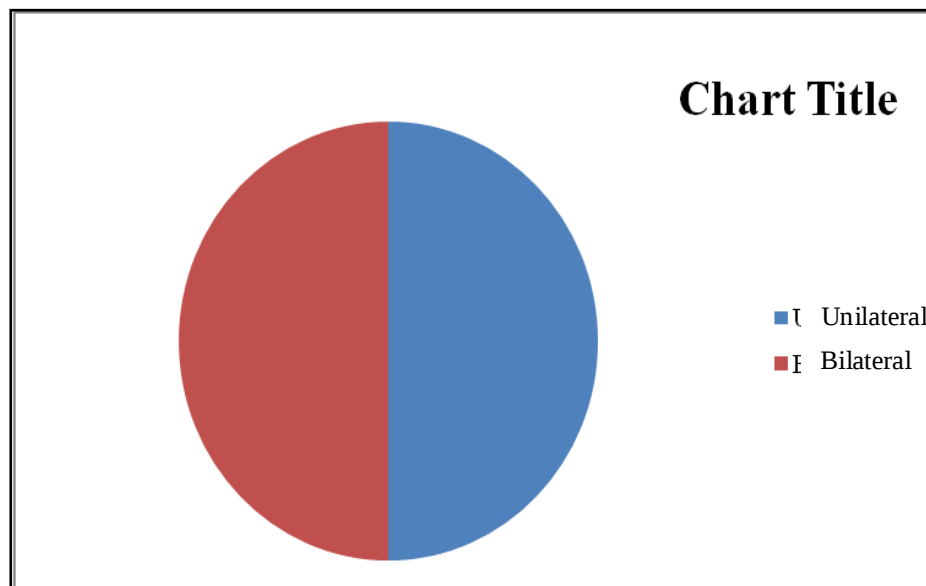


Figure 3: Laterality in patients with Pseudoexfoliation Syndrome

In the present study there were 45 (50%) of patients had clinical bilateral involvement of Pseudoexfoliation syndrome and 45 (50%) had unilateral involvement.

TABLE 4 : ANGLE CONFIGURATION IN PSEUDOEXFOLIATION
SYNDROME

ANGLE CONFIGURATION	NUMBER OF PATIENTS	PERCENTAGE
Open angles	80	89%
Narrow angles	10	11%
Total	90	100%

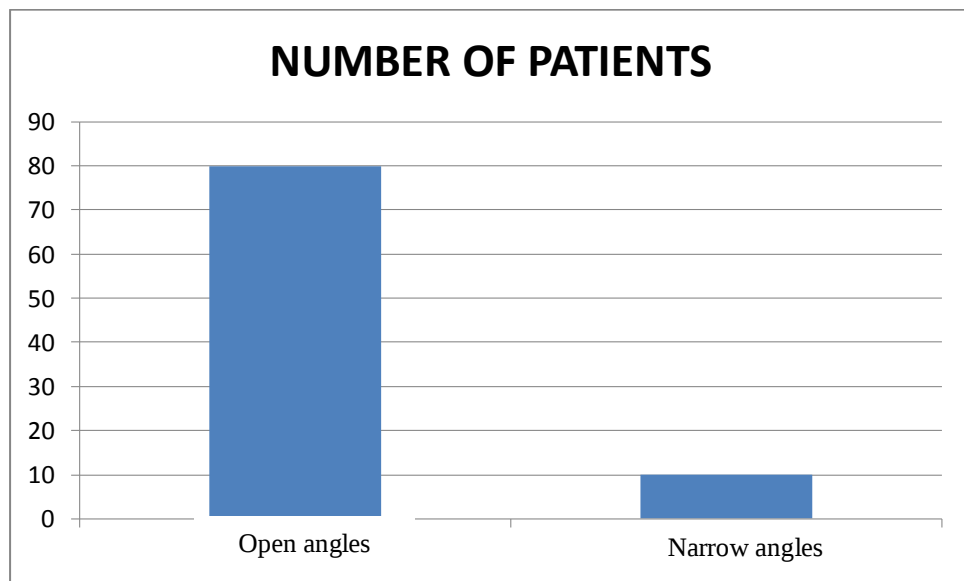


Figure 4: Angle Configuration in Pseudoexfoliation Syndrome

In the present study, of the 90 patients with Pseudoexfoliation syndrome, 80(89%) of patients had open angles and 10(11%) patients had narrow angles.

TABLE 5: COMPARISON OF PRE AND POST PUPIL DILATATION SIZE

	Group A	Group B	P value
Pre-dilatation	2.92±0.38	2.87±0.35	0.547
Post-dilatation	6.02±1.03	6.07±1.05	0.830

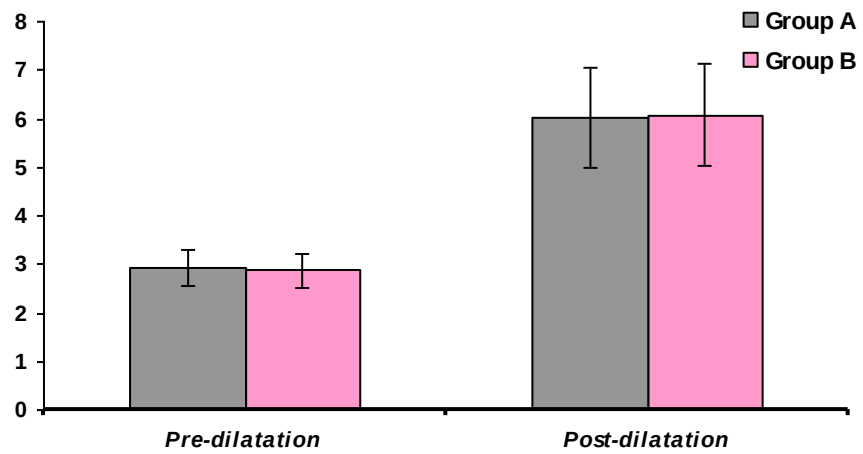


TABLE 6: COMPARISON OF PUPIL IN TWO GROUPS OF PATIENTS

Pre-dilatation	Group A (n=60)	Group B (n=30)	P value
Shape			
Round	3(5.0%)	0	0.548
Irregular	57(95.0%)	30(100.0%)	
Reaction			
Normal	58(96.7%)	30(100.0%)	0.551
SR	2(3.3%)	0	

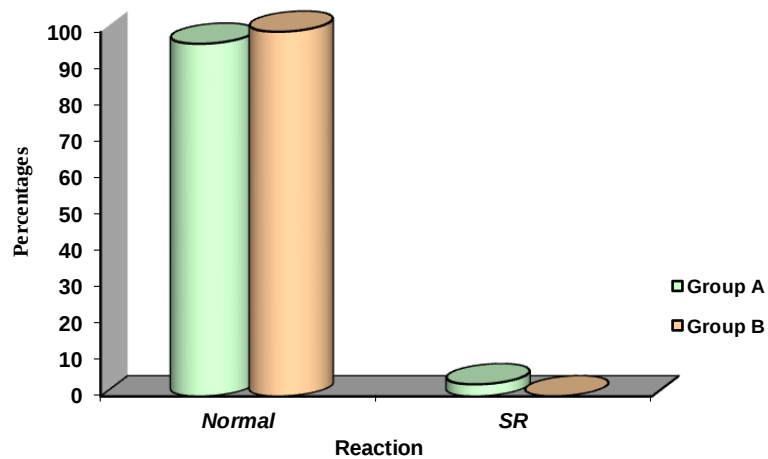
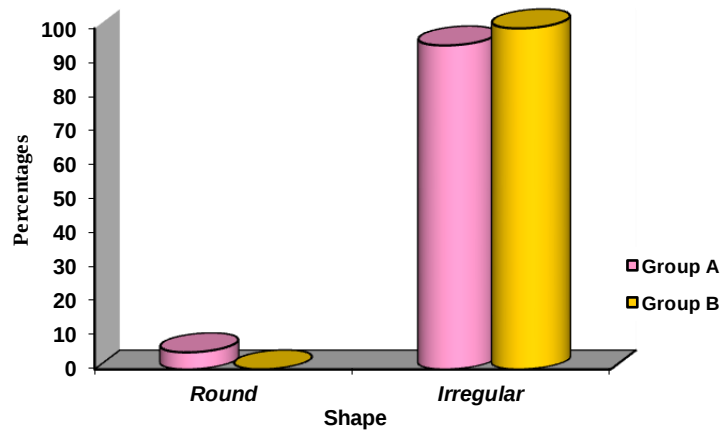


TABLE 7: COMPARISON OF TYPE OF CATARACT IN TWO GROUPS OF PATIENTS

Type of cataract	Group A (n=60)	Group B (n=30)
NS 1-2	18(30.0%)	13(43.3%)
NS 2-3	23(38.3%)	8(26.7%)
NS 3-4	2(3.3%)	2(6.7%)
PPC	2(3.3%)	1(3.3%)
PSC	3((5.0%)	2(6.7%)
SMC	12(20.0%)	4(13.3%)

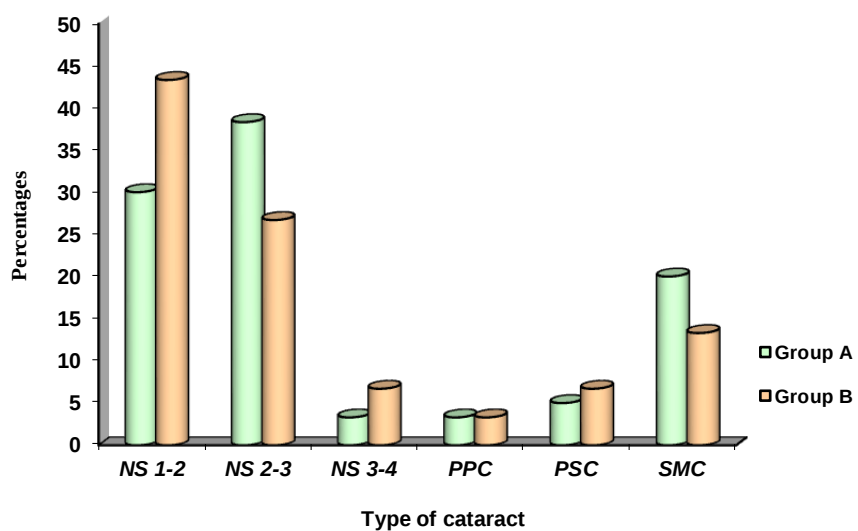


TABLE 8: COMPARISON OF COMPLICATIONS IN TWO GROUPS OF PATIENTS

Complications	Group A (n=60)	Group B (n=30)	P value
PC	6(10.0%)	5(16.7%)	0.497
DIT	0	3(10.0%)	0.035*
DIC	2(3.3%)	0	0.551
ID	0	0	-
PCR	1(1.7%)	1(3.3%)	1.000
VL	0	0	-
ND	0	0	-
ZD	1(1.7%)	0	1.000
OTHERS	0	0	-

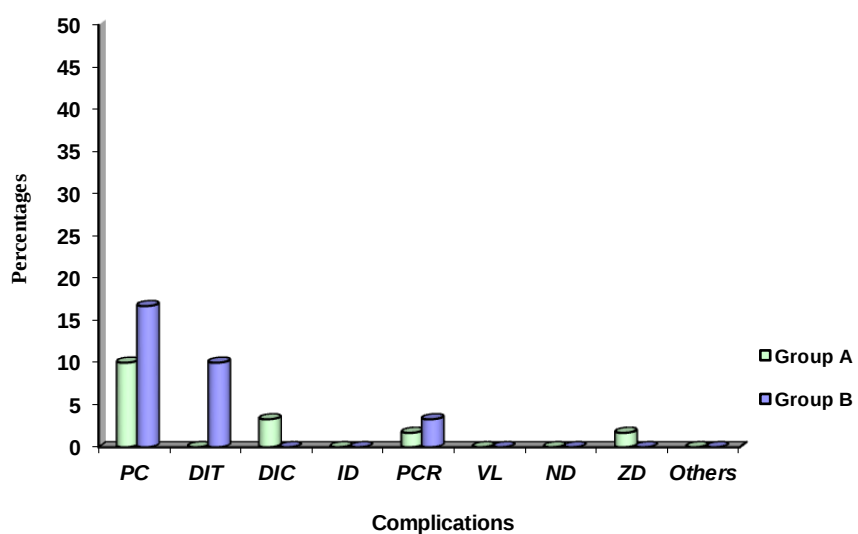
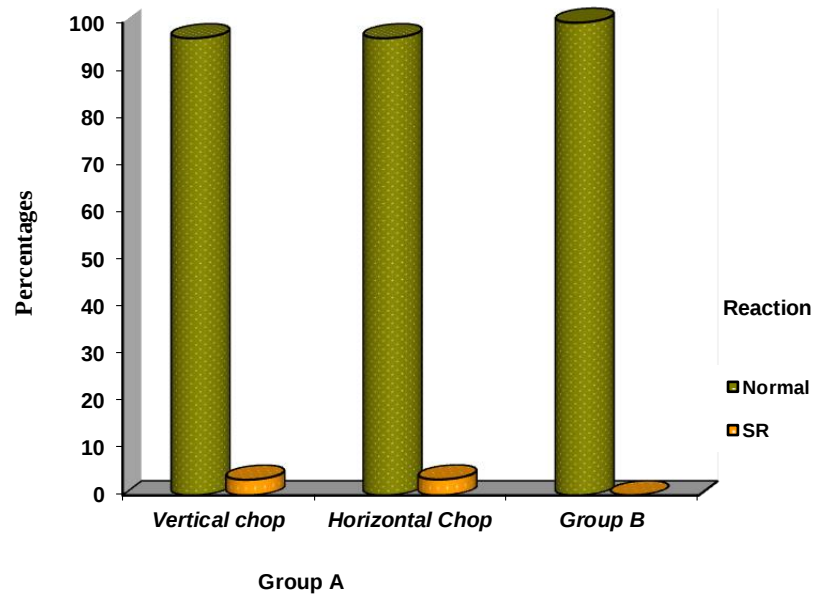
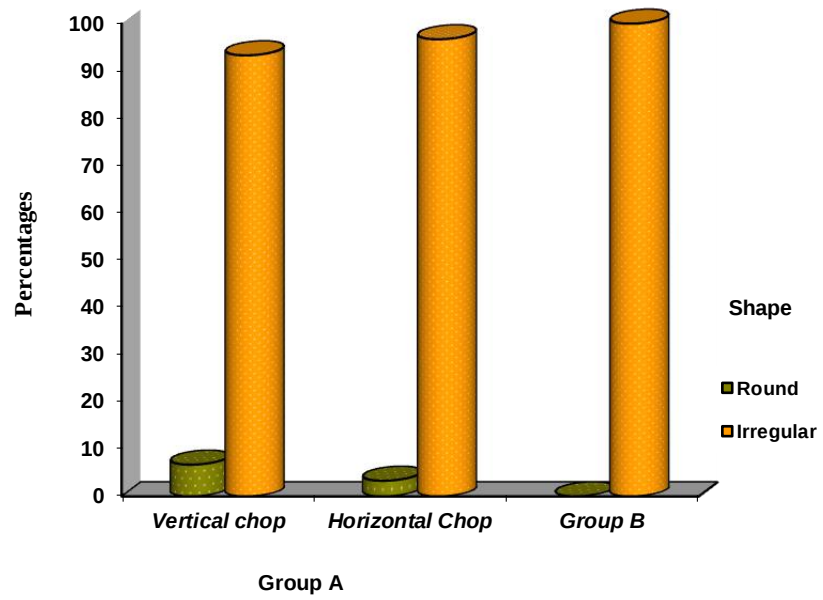


TABLE 9: COMPARISON OF BASIC AND CLINICAL VARIABLES IN THREE GROUPS OF PATIENTS

Variables	Group A		Group B (n=30)	P value
	Vertical chop (n=30)	Horizontal chop (n=30)		
Age in years	60.20±5.70	62.73±9.07	61.17±5.34	0.362
Gender M;F	17:13	11:19	23:7	0.008**
Predilatation				
Size(mm)	2.83±0.38	3.00±0.37	2.87±0.35	0.181
Shape				
• Round	2(6.7%)	1(3.3%)	0	0.770
• Irregular	28(93.3%)	29(96.7%)	30(100.0%)	
Reaction				
• Normal	29(96.7%)	29(96.7%)	30(100.0%)	1.000
• SR	1(3.3%)	1(3.35)	0	
Post dilatation size (mm)	5.97±1.03	6.07±1.05	6.07±1.05	0.912



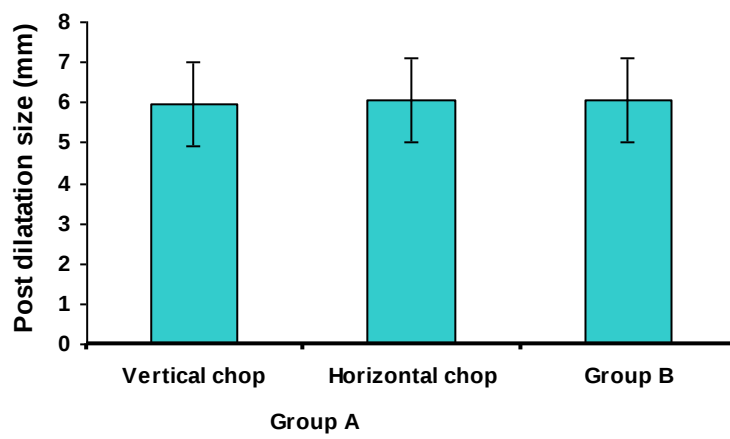
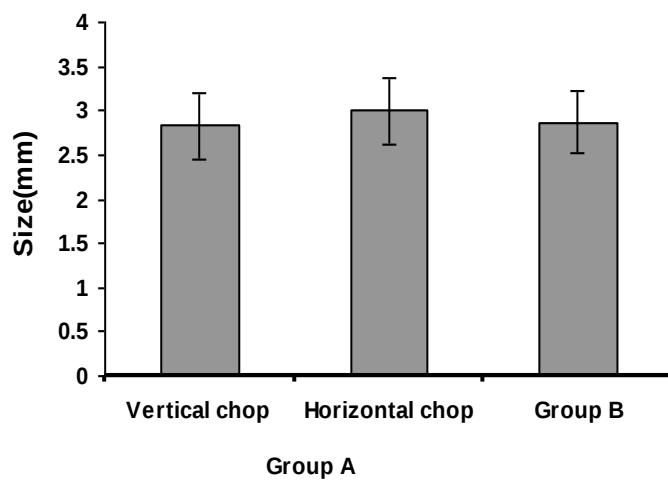
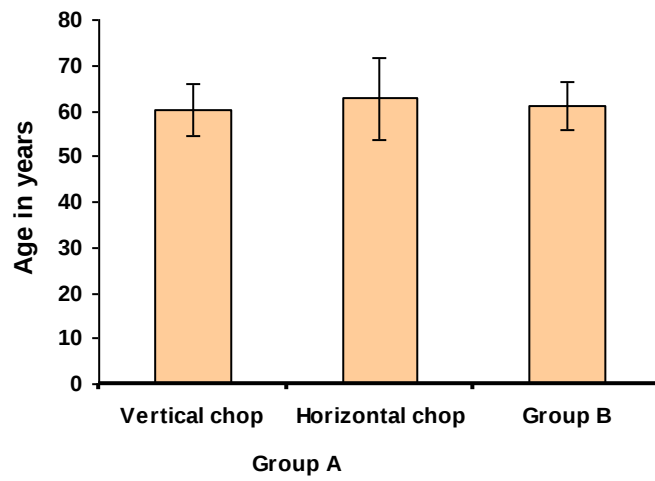


TABLE 10: COMPARISON OF TYPE OF CATARACT IN THREE GROUPS OF PATIENTS

Type of cataract	Group A		Group B (n=30)	P value
	Vertical chop (n=30)	Horizontal chop (n=30)		
NS 1-2	8(26.7%)	10(33.3%)	13(43.3%)	0.433
NS 2-3	14(46.7%)	9(30.0%)	8(26.7%)	0.240
NS 3-4	1(3.3%)	1(3.3%)	2(6.7%)	1.000
PPC	1(3.3%)	1(3.3%)	1(3.3%)	1.000
PSC	1(3.3%)	2(6.7%)	2(6.7%)	1.000
SMC	5(16.7%)	7(23.3%)	4(13.3%)	0.696

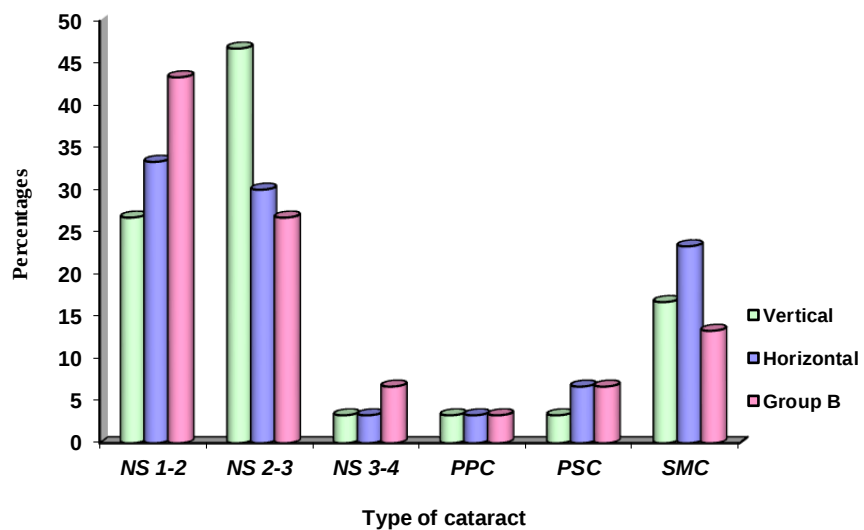


TABLE 11: COMPARISON OF COMPLICATIONS IN THREE GROUPS OF PATIENTS

Complications	Group A		Group B (n=30)	P value
	Vertical chop (n=30)	Horizontal chop (n=30)		
PC	2(6.7%)	4(13.3%)	5(16.7%)	0.524
DIT	0	0	3(10.0%)	0.104
DIC	0	2(6.7%)	0	0.326
ID	0	0	0	-
PCR	0	1(3.3%)	1(3.3%)	1.000
VL	0	0	0	-
ND	0	0	0	-
ZD	0	1(3.3%)	0	1.000
OTHERS	0	0	0	-

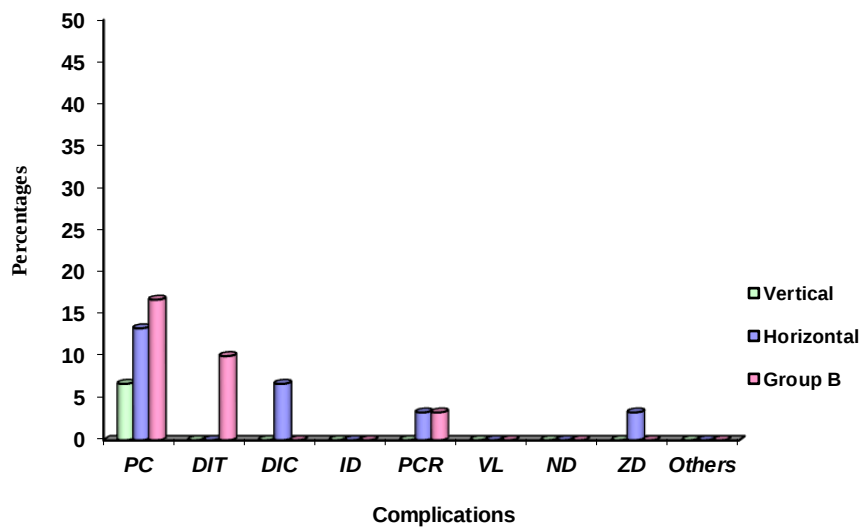


TABLE 12- SURGICAL MODIFICATIONS IN PATIENTS WITH
PSEUDOEXFOLIATION SYNDROME

MODIFICATION	NUMBER OF PATIENTS
Sphincterectomy	24
Synechiolysis	13
Both	10

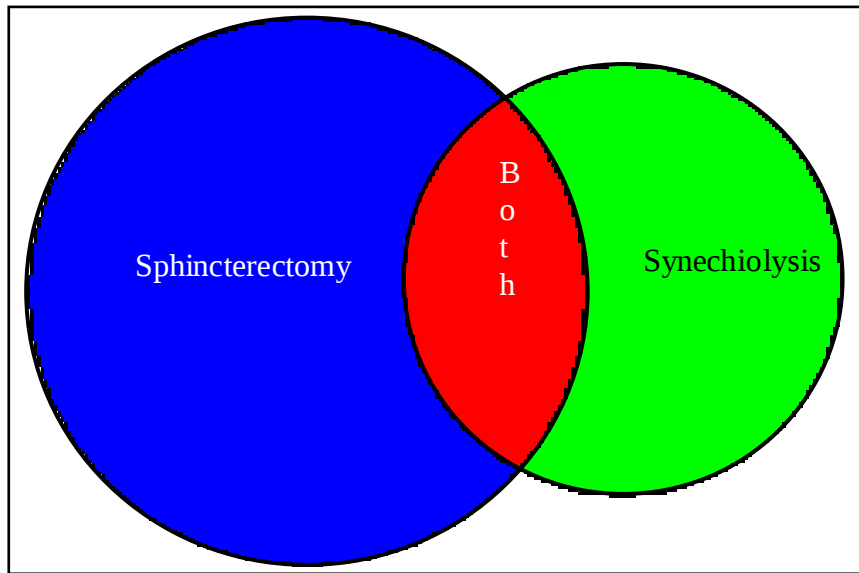


Figure 12: Surgical Modification in Patients with Pseudoexfoliative Syndrome

In the present study, 13 (14.44 %) underwent Synechiolysis, 24 (25.55%) patients underwent sphincterotomy and 10 (11.11%) patients underwent both sphincterotomy and Synechiolysis.

DISCUSSION

This study consisted of 90 patients with Pseudoexfoliation syndrome who underwent Phacoemulsification surgery in R L JALAPPA HOSPITAL AND RESEARCH CENTER, TAMAKA, KOLAR attached to Sri Devaraj Urs Medical college.

As shown in **Table 1**, there were 8(8.8%) patients of age group 48 – 50 years, 36 (41%) patients of age group 51 – 60 years and 42 (46 %) of age group 61 – 70 and 4(4.4%) above the age of 70 years. The average age of patients was 61 years and about 46 (51.00 %) of patients were above 60 yrs of age. The prevalence of Pseudoexfoliation syndrome increases with age. Pseudoexfoliation syndrome usually occurs between 60 to 80 yrs, the average age being 70 yrs. In this study, 51.00 % of the patients are in the age group of 60 – 90 years which is in concurrence with the mentioned studies.

As shown in **Table 2**, 51 (56.6%) were males and 39 (43.00%) were females. Studies regarding the sex distribution of Pseudoexfoliation syndrome are conflicting. Women have predominated in some series while other studies have found equal or greater prevalence in men.

As shown in **Table 3**, 45 (50%) of patients had clinical bilateral involvement of Pseudoexfoliation syndrome and 45 (50%) had unilateral involvement. A review of literature comparing the frequency of monocular versus binocular involvement in various series is not conclusive. Many series have reported bilateral involvement to be more common with ratios as high as 3:1 while other studies have reported unilateral involvement to predominate again with ratios as high as 3:1.

Hammer, Schlotzer- Schrehardt, Naumann⁵⁵ in 2001 carried out an ultrastructural study of the contralateral eye in 5 pairs of donor eyes with unilateral

Pseudoexfoliation syndrome. They showed “ultrastructural” alterations in anterior segment tissues of all the eyes. They concluded that basically Pseudoexfoliation syndrome is a bilateral disease with clinically marked asymmetric manifestations. The reasons for this marked asymmetry remain unknown. Clinically unilateral involvement is often a precursor to bilateral involvement within 5- 10 yrs after diagnosis.

As shown in **Table 4**, of the 90 patients, 80(89%) of patients had open angles and 10(11%) patients had narrow angles. Out of 10 narrow angles, 4 patient had narrow angle due to anterior subluxation of the lens, 3 patient had narrow angles due to synechial angle closure and 3 patient had narrow angles due to appositional angle closure. The present study is in concurrence with the following studies. In studies of patients with Pseudoexfoliation syndrome, occludable angles were noted in 9-18% of patients (Bruce shields 1999, fourth edition).

Ritch, Schlotzer- Scherhardt (2001) noted 23% of patients with Pseudoexfoliation syndrome and glaucoma to have grade 2 or narrow angles.

Wishartetal^{56, 57} (1985) noted 32% of patients in their study to have narrow angles.

As shown in **Table 5**, 46 (51 %) of patients had sufficient mydriasis, and 44 (49 %) of the patients had insufficient mydriasis. This is in concurrence with the following studies.

As shown in **Table 6**, before dilatation of the pupil , 95% in group A and 100% in Group B were irregular in shape and 96.7% in Group A and 100% in Group B, pupils were normally reacting to light.

Freyler H, Radax U (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 (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 (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 (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 (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, Sakkiak G (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.

In the present study, 20 % had pigment dispersion after mydriasis. Prince, A.M., Ritch R⁵⁸ (1986) reported that anterior chamber melanin dispersion after mydriasis may be seen as a whorl like pattern of pigment particles on iris sphincter and peripheral iris.

Ritch R, Schlotze – Scherhardt⁵⁹ (2000) reported pigment dispersion in the anterior chamber after mydriasis to be common and profuse in Pseudoexfoliation syndrome. Pigment dispersion after mydriasis is one of the suspicious sign to meticulously look out for Pseudoexfoliation syndrome in preclinical stages.

As shown in **Table 7** and **10** , 81%, had Nuclear Cataracts. Cortical Cataract was present along with advanced nuclear cataract and none of the patients had isolated cortical cataract.

Seland et al⁶⁰ (1982) have reported a higher incidence of nuclear cataract in eyes with pseudoexfoliation syndrome with fewer cortical cataracts. Hietanen J. et al have also reported nuclear cataract to be the predominant type of cataract in Pseudoexfoliation syndrome.

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

As shown in **Table 8, 9** and **11** , patients who underwent Vertical chopping technique 2(6.7%) had pupil constriction, in patients who underwent horizontal chopping, 4(13.3%) had pupil constriction, 2(6.7%) had difficulty in chopping, 1(3.3%) had zonular dehiscence and 1(3.3%) had PC Rent. Patients who underwent divide and conquer technique 5(16.7%) had pupil constriction, 3(10%) had difficulty in trenching, 1(3.3%) had PC Rent.

Scrolloli et al (1998) have found that PEX patients were five times more likely to develop intraoperative complications during cataract surgery compared to patients without the condition. Schonherrs U et al (1989) found a statistically significant increase in intraoperative and postoperative complication in eyes with Pseudoexfoliation syndrome in their study of 436 patients. Freyler H, Radax U (1990) found 26 of their 36 patients with pseudoexfoliation syndrome undergoing ECCE to have intraoperative complications such as Zonular dehiscence, Posterior capsular rent and Vitreous loss.

Various studies in eyes with Pseudoexfoliation syndrome have quoted the incidence of Zonular dehiscence to be 17.90%. Hovding G (1998), 13.1% by Avramides S (1997) and 14.8% by Lumme P, Laatikanan (1993). Alfaite et al (1996) in their study of 31 patients found zonular dehiscence to be more common in eyes with Pseudoexfoliation syndrome but this was not statistically significant when compared to eyes without Pseudoexfoliation syndrome.

Stanila (1996) also reported an increased incidence of Posterior capsular rent and Vitreous loss in their study of 10 eyes with Pseudoexfoliation syndrome undergoing ECCE. Kuchle et al (2000) found 6.9% of their 11 patients to have intraoperative complication namely – zonular dehiscence and vitreous loss. Zonular fragility in Pseudoexfoliation syndrome increases the risk of lens dislocation, zonular dehiscence and vitreous loss up to 10 times (Ritch R, 2001).

Lumme P, Laatikanan L (1993) found the incidence of vitreous loss to be fourfold more in eyes with Pseudoexfoliation syndrome and Posterior capsular rent to be 10 fold higher in eyes with Pseudoexfoliation syndrome. Avramides S., Travamides P, Sakkias G (1997) found the incidence of Posterior capsular rent and vitreous loss to be 10.4% and 7.14% respectively in this study of 84 patients with Pseudoexfoliation syndrome undergoing cataract surgery. The incidence of vitreous loss in eyes with Pseudoexfoliation syndrome undergoing cataract surgery has been reported by various authors as 11.9% by Kuchle (1989) and 6.7% by Junemann A, Martus P, et al (1997). Naumann G.O., Kucle M. Schonher U (1978) in their study of 72 eyes with Pseudoexfoliation syndrome found a seven fold increase for vitreous loss in eyes with Pseudoexfoliation syndrome as compared to those without Pseudoexfoliation syndrome.

They also noted the incidence of posterior capsular rent to be 4.2% in eyes with Pseudoexfoliation syndrome and 2.8% without Pseudoexfoliation syndrome. This correlates with the other studies conducted by Freyler H., Radax U (1990), Asano N. et al (1996), Repo L.P. et al (1996), Stanilla A. (1996) and Avramides S et al (1997).

As shown in **Table 12**, 13 (14.44 %) underwent Synechiolysis, 23 (25.55 %) patients underwent sphincterotomy and 10 (11.11 %) patients underwent both sphincterotomy and Synechiolysis.

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

Vickie Lee and Anthony Maloof (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 (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 Intra operative posterior capsule complications.

In this study, he interpreted that in Phacoemulsification, Pseudoexfoliation syndrome has an increased intraoperative posterior capsule complication rate that increases as the level of cataract maturity increases. Thereby, 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.

CONCLUSIONS

Patients with pseudoexfoliation syndrome and cataract for phacoemulsification surgery, have to be carefully looked for zonular weakness, insufficient mydriasis, IOP, subluxation or dislocation of cataractous lens because these preoperative factors have bearing on the intraoperative complications.

Inadequate mydriasis is one of the major pre operative complications in eyes with Pseudoexfoliation syndrome which has a bearing on the intra operative complications like posterior capsular rent and vitreous loss. Adequate surgical modifications such as Sphincterotomy and/or synechiolysis, pupil stretching, use of iris hooks in these eyes with inadequate mydriasis reduce the intra operative complications. In our study Intra operative complications noted in Vertical chopping technique was only pupil constriction in 6.7% , no other complications were seen in this technique, whereas in horizontal chopping , 13.3% had pupil constriction, 6.7% had difficulty in chopping, 3.3% had zonular dehiscence and 3.3% had PC Rent, and in divide and conquer technique 16.7% had pupil constriction, 10% had difficulty in trenching, 3.3% had PC Rent. 97.8% of the patients were implanted with intraocular lens after employment of various surgical modifications.

We found that chopping techniques are best suited for PEX and amongst these vertical chopping scores over horizontal chopping as it has fewer complications, because of the good visualization of the chopper throughout, the avoidance of proximity to the capsular bag and decrease pressure on the zonules, resulting in increased safety.

SUMMARY

In the present study, 90 patients with both Cataract and Pseudoexfoliation syndrome, attending, R L JALAPPA hospital and research center, attached to Sri Devraj Urs medical college, Tamaka, Kolar were included. The average age group of these patients was 61.7 years with preponderance of males with equal incidence of unilateral and bilateral involvement.

In the present study, majority of the patients had Pseudoexfoliation material on the pupillary margin with 100% patients having different grades of trabecular pigmentation with 90% of the patients having open angles, 70% patients had IOP within normal range, 20 % of the patients had open angle glaucoma and 10% having secondary angle closure glaucoma. 46.67 % of the patients had insufficient mydriasis. 100 % of the patients had either peripheral zone or central zone or both of the pseudoexfoliation material on the anterior surface of the lens suggesting Pseudoexfoliation syndrome. 30 % of patients had cataract maturity level more than nuclear sclerosis grade 4.

In our study, 3.4% of the patients had intraoperative complications. Intraoperative complications noted in Vertical chopping technique was only pupil constriction in 6.7% , no other complications were seen in this technique, whereas in horizontal chopping , 13.3% had pupil constriction, 6.7% had difficulty in chopping, 3.3% had zonular dehiscence and 3.3% had PC Rent, and in divide and conquer technique 16.7% had pupil constriction, 10% had difficulty in trenching, 3.3% had PC Rent.

97.8% of the patients were implanted with intraocular lens after employment of various surgical modifications.

Phacoemulsification is the best suited technique for patients with pseudoexfoliation syndrome and out of various phaco nucleotomy techniques, vertical chop yields better results than horizontal chopping and divide and conquer techniques.

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ANNEXURE I:

**PROFORMA FOR THE STUDY OF INTRAOPERATIVE
COMPLICATIONS OF PHACOEMULSIFICATION SURGERY IN EYES
WITH PSEUDOEXFOLIATION.**

CASE NUMBER:

NAME:

AGE:

SEX:

I.P. NO./O.P. NO.:

DATE OF ADMISSION:

DATE OF DISCHARGE:

FINAL DI AGNOSIS:

PRESENTING COMPLAINTS:

HISTORY OF PRESENTING COMPLAINTS:

GENERAL PHYSICAL EXAMI NATION:

OCULAR EXAMINATION:

EXAMINATION	RIGHT EYE	LEFT EYE
VISUAL ACUITY		
DISTANT VISION – Uncorrected – Pin Hole – Corrected		
NEAR VISION		
ANTERIOR SEGMENT EVALUATION		
ADNEXA		
CONJUNCTIVA		
SCLERA		
CORNEA		
ANTERIOR CHAMBER		

– AC Depth – Pigment Dispersion		
--	--	--

EXAMINATION	RIGHT EYE	LEFT EYE
IRIS – Colour – Pattern – Moth eaten appearance – Posterior synechiae – Others		
PUPIL – Size – Shape – Reaction – Direct – Indirect – PEX on Pupillary margin		
LENS Type of Cataract Zones of PEM Phacodonesis Subluxation Dislocation Others		
FUNDUS		
Direct Ophthalmoscopy		

Indirect Ophthalmoscopy		
INTRA- OCULAR PRESSURE		
By Schiotz Tonometry		
LACRIMAL PATENCY TEST		
EXAMINATION	RIGHT EYE	LEFT EYE
GONIOSCOPY		
Angle (by Schaffer's Classification)		
Trabecular pigmentation		
Pseudoexfoliative material		
Sampolesi's Line		
Others		
POST-MYDRIASIS		
Pupil size		
Pigment Dispersion		
EXTRA-OCULAR MUSCLE MOVEMENTS		
VISUAL FIELD		
By Confrontation Method		

A SCAN ESTIMATION OF POWER OF IOL

PRE-OPERATIVE PREPARATION:

OPERATIVE NOTES:

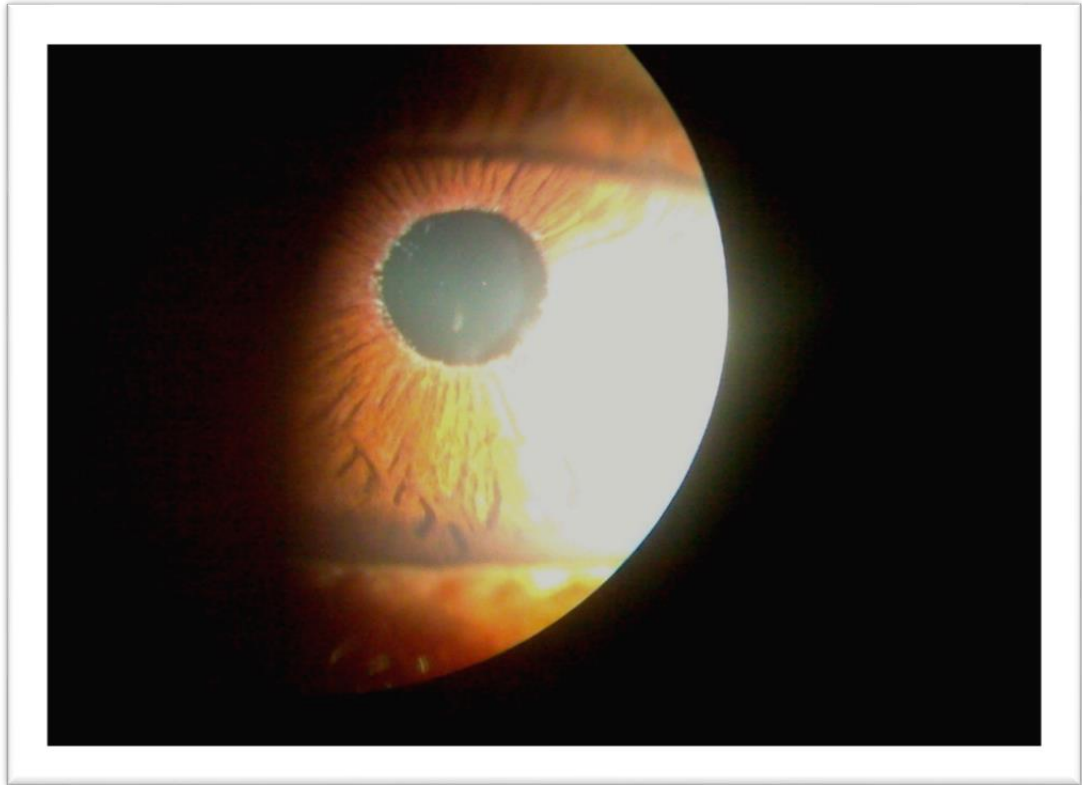
DATE:

SURGEON:

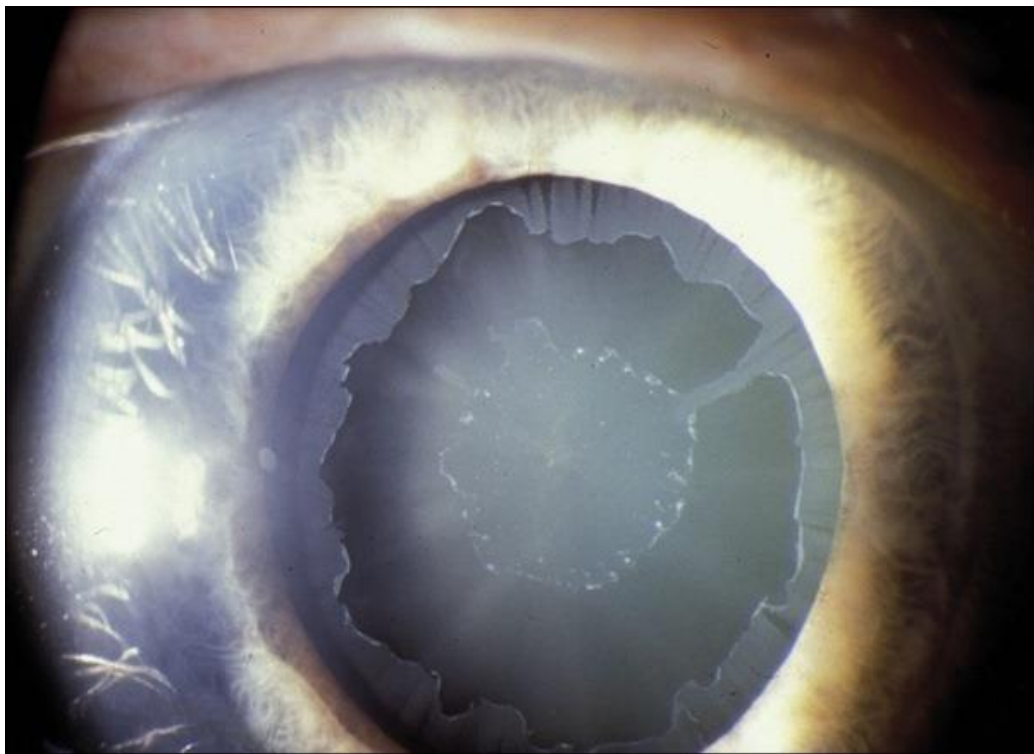
PROCEDURE:

INTRAOPERATIVE COMPLICATIONS:

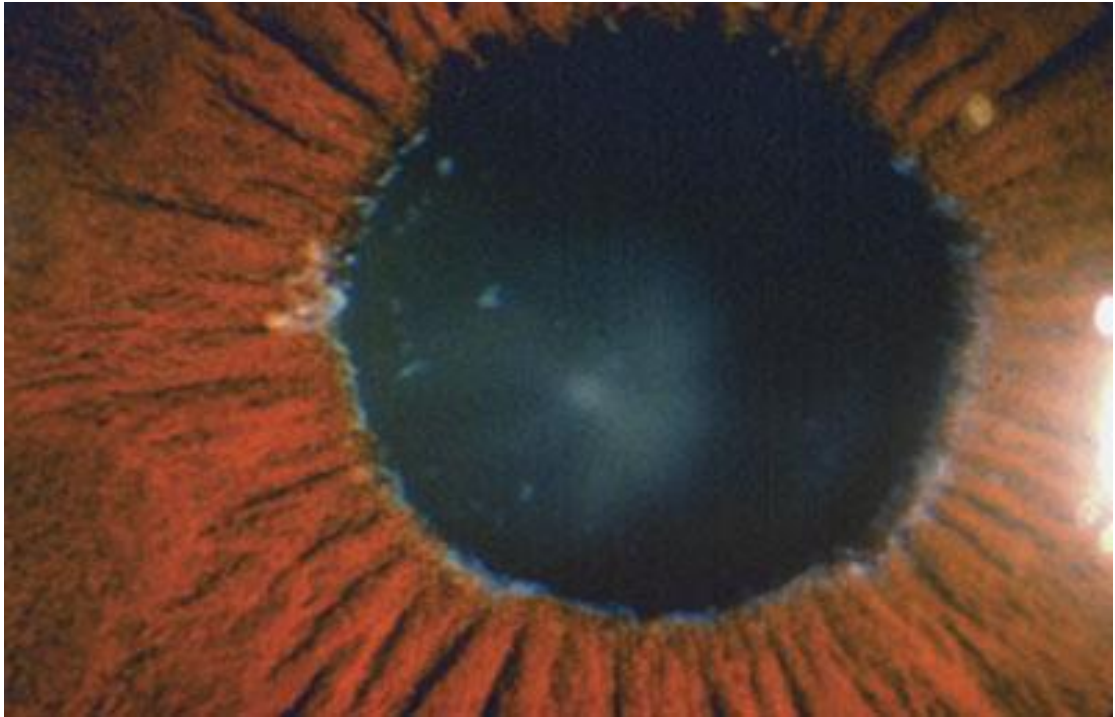
<u>TECHNIQUES</u>	<u>CHOPPING</u> VERTICAL	<u>TECHNIQUES</u> HORIZONTAL	DIVIDE AND CONQUER
<u>Complications</u> Pupil Constriction Capsulorrhexis -Extension or Tear Difficulty in Trenching Difficulty in Chopping Iridodialysis Zonular Dialysis Posterior Capsule Rent Vitreous Loss Nuclear Drop Others			



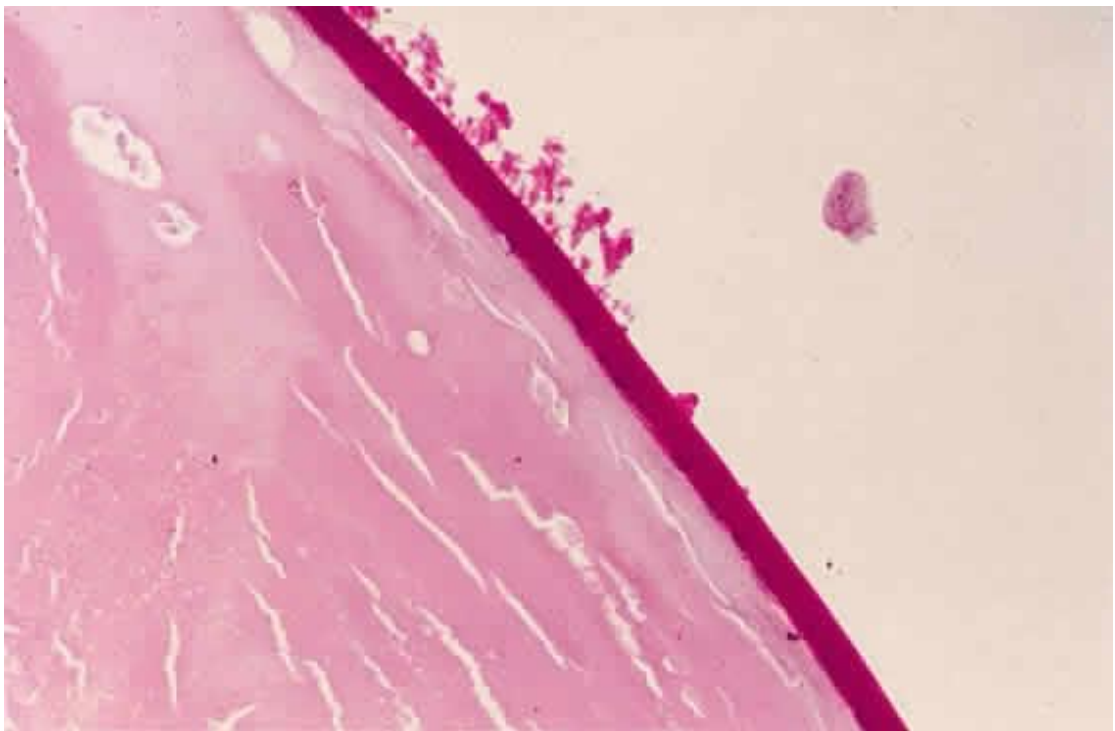
Photograph 1: Pseudoexfoliation material at the pupillary margin and anterior surface of lens capsule with undilated pupil.



Photograph 2: Zone of pseudoexfoliative material on the anterior capsule of lens after pupillary dilatation



Photograph 3: Pseudoexfoliative material at the pupillary border after dilatation.



Photograph 4: Histopathology of pseudoexfoliative material on the anterior lens capsule

KEY TO MASTER CHART

SI No : Serial Number

IP No: In Patient Number

M: Male

F: Female

SR: Sluggishly reacting

NS: Nuclear sclerosis

SMC: Senile mature cataract

PPC: Posterior polar cataract

PSC: Posterior subcapsular cataract

VC: Vertical Chop

HC: Horizontal Chop

D&C: Divide and Conquer

PCIOL: Posterior Chamber Intra Ocular Lens

PC: Pupil constriction

DIT: Difficulty in Trenching

DIC: Difficulty in chopping

ID: Iridodialysis

PCR: Posterior Capsule Rent

VL: Vitreous Loss

ZD: Zonular dialysis