

A Clinical Study of Management and Visual Outcome in Small Pupil with Cataract at a Tertiary Care Centre

Dr.N.Padmavathi¹ Dr.B.Usha latha²

¹Assistant Professor In Ophthalmology, Rangaraya Medical College, Kakinada

²Assistant Professor In Ophthalmology, Rangaraya Medical College, Kakinada

Corresponding author: Dr.B.Ushalatha

Abstract:

Aims & objectives: To study the factors responsible for development of small pupil with cataract, to study the pharmacological and surgical treatment of small pupil with cataract

Materials methods: A prospective study of 100 cases was done on the management and visual outcome in small pupil with cataract from December-2014 to JULY-2016 on the patients attending the Government General Hospital, Kakinada.

Results: In this study 31 cases (31%) had posterior synechia, 25 cases (25%) had pxf and 44 cases (44%) had spasmodic pupil as a cause for small pupil.

Discussion: Pseudoexfoliation syndrome is more common in females than in males and its prevalence increases steadily with age. In our study majority of cases had cortical type of cataract. 51 cases (51%) and 43 cases (43%) had nuclear type of cataract. In the nuclear type of cataract highest number were grade-2 and grade-3.

Conclusion: Small pupil with cataract presents challenges that requires careful preoperative planning and intraoperative care to ensure successful and safe surgery.

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I. Introduction

Cataract is currently the main cause of avoidable blindness in the developing world accounting for about three quarters of blindness.¹ Indians were the first to begin operations on cataract by mastering the technique of "Couching". "Sushruta", practiced this technique in 800 AD and is considered as the father of cataract surgery.² The techniques of cataract surgery have progressed rapidly and continue to change with refinements in each step to provide highest quality results anatomically and functionally.

One of the most important things in cataract surgery is pupil size. Unfortunately, significant number of patients fail to show appropriate response to topical mydriatic agents, resulting in small, poorly dilated pupils, smaller than 4mm. Cataract surgery through small pupil is associated with a higher incidence of intra-operative complications such as capsular rupture, vitreous loss, dropped nucleus, endothelial loss and zonular dehiscence.

Many factors may cause small pupil. The most important causes are pseudoexfoliation(PXF) syndrome, chronic miotic therapy, previous trauma or surgery, uveitis with synechiae, diabetes mellitus, and recently the intraoperative floppy iris syndrome(IFIS).

AIMS AND OBJECTIVES: The present study aims at studying the factors responsible for development of small pupil with cataract., to study the pharmacological and surgical treatment of small pupil with cataract and to study the final visual outcome in different types of small pupil with cataract.

MATERIALS AND METHODS: A prospective study of 100 cases was done on the management and visual outcome in small pupil with cataract from December-2014 to JULY-2016 on the patients attending the Government General Hospital, Kakinada.

Inclusion criteria: patients of Pseudoexfoliation with cataract, inflammatory posterior synechia, spastic or sclerosed pupil in old age were included for the study..

Following patients were excluded from the study: Patients with retinal diseases, Glaucoma medication with pilocarpine, Previous intraocular surgery, Corneal disease.

A detailed history pertaining to eye and systemic diseases was followed by ocular examination with particular reference to type of cataract and its nuclear grading was done in all patients.

OBSERVATIONS AND RESULTS

TABLE 1: AGE DISTRIBUTION

Age	Frequency	Percent
40-60	51	51.0
61-80	47	47.0
81-100	2	2.0
Total	100	100.0

In this study most of the patients [51 cases (51%)] were in the age group of 40-60 yrs, and 47 cases (47%) were between 61-80 yrs, 2 (2%) cases were between 81-100 yrs.

TABLE 2: SEX DISTRIBUTION

sex	Frequency	Percent
Female	60	60.0
Male	40	40.0
Total	100	100.0

In our study 60 cases (60%) were females and 40 cases (40%) were males.

TABLE 3: TYPE OF CATARACT

Type of cataract	Frequency	Percent
CC	51	51.0
NS-1	3	3.0
NS-2	22	22.0
NS-3	13	13.0
NS-4	5	5.0
PSCO	6	6.0
Total	100	100.0

In our study 51 cases (51%) had cortical cataract and 43 cases (43%) had nuclear cataract and 6 cases (6%) had posterior sub capsular opacity (PSCO). Nuclear cataract there was predominance of grade 2 and grade-3 nucleus

TABLE 4: CAUSES OF SMALL PUPIL

Causes of small pupil	Frequency	Percent
P.S	31	31.0
PXF	25	25.0
S.S	44	44.0
Total	100	100.0

In this study 31 cases (31%) had posterior synechia, 25 cases (25%) had pxf and 44 cases (44%) had spasmodic pupil as a cause for small pupil.

INTRAOPERATIVE COMPLICATIONS:

TABLE 5: DESCEMETS DETACHMENT

Descemets Detachment	Frequency	Percent
Absent	98	98.0
Present	2	2.0
Total	100	100.0

Descemets detachment is seen in 2 cases (2%)

TABLE 6: HYPHAEMA

Hyphaema	Frequency	Percent
Absent	94	94.0

Present	6	6.0
Total	100	100.0

In our study hyphaema seen in 6 cases (%)

TABLE 7: ANTERIOR CHAMBER COLLAPSE:

AC Collapse	Frequency	Percent
Absent	99	99.0
Present	1	1.0
Total	100	100.0

In our study AC collapse seen in 1 case (1%)

TABLE 8: DIFFICULTY IN NUCLEUS DELIVERY:

Difficult Nucleus Delivery	Frequency	Percent
Absent	95	95.0
Present	5	5.0
Total	100	100.0

In our study difficulty in nucleus delivery was seen in 5 cases(5%)

TABLE 9: IRIDODIALYSIS

Iridodialysis	Frequency	Percent
Absent	97	97.0
Present	3	3.0
Total	100	100.0

In our study iridodialysis seen in 3 cases(3%).

TABLE 10: POSTERIOR CAPSULE RENT WITH VITREOUS LOSS

PC Rent VL	Frequency	Percent
Absent	98	98.0
Present	2	2.0
Total	100	100.0

In our study posterior capsule rent with vitreous loss is seen in 2 cases (2%).

TABLE 11: PC RENT WITHOUT VITREOUS LOSS

PC Rent NO VL	Frequency	Percent
Absent	98	98.0
Present	2	2.0
Total	100	100.0

In our study posterior capsule rent without vitreous loss is seen in 2 cases (2%).

POST-OPERATIVE COMPLICATION:

TABLE 12: STRIATE KERATOPATHY

Striate Keratopathy	Frequency	Percent
Absent	89	89.0
Present	11	11.0
Total	100	100.0

In our study post operative striate keratopathy is seen in 11 cases (11%).

TABLE 13: UVEITIS

Uveitis	Frequency	Percent
Absent	95	95.0
Present	5	5.0
Total	100	100.0

In our study post operative uveitis is seen in 5 cases (5%).

TABLE 14: ATONIC PUPIL

Atonic pupil	Frequency	Percent
Absent	89	89.0
Present	11	11.0
Total	100	100.0

In our study post operative atonic pupil was seen 11 cases (11%)

TABLE 15: HYPHAEMA

Hyphaema	Frequency	Percent
Absent	97	97.0
Present	3	3.0
Total	100	100.0

In our study post operative hyphaema was seen with 3 cases (3%).

II. Discussion

Hundred patients undergoing cataract surgery with small pupil were included in the study. All patients underwent manual small incision cataract surgery.

AGE DISTRIBUTION:

In our study, patients were in the age group between 40-100 years. 51 patients (51%) were between 40 and 60 years, 47 patients (47%) were between 61 and 80 years, and 2 patients were between 81 and 100 years. Pseudoexfoliation syndrome is more common in females than in males and its prevalence increases steadily with age and is rarely seen before the age of 50s.

SEX DISTRIBUTION:

In our study females were 60 (60%) cases and males 40 cases (40%)

Some previous studies showed male preponderance while Aravind et al. in 2003 showed no sex predilection.⁵⁵ Avramides, Sakkias and Traindis reported a female preponderance.⁵⁸

TYPES OF CATARACT:

In our study majority of cases had cortical type of cataract. 51 cases (51%) and 43 cases (43%) had nuclear type of cataract. In the nuclear type of cataract highest number were grade-2 and grade-3.

CAUSES OF SMALL PUPIL:

In our study cause of small pupil in 31 cases (31%) were due to posterior synechiae, 25 cases were due to pseudoexfoliation and 44 cases were due to sclerosed pupil.

INTRAOPERATIVE COMPLICATIONS:

DESCEMETS DETACHMENT

In our study descemets detachment was seen in 2 cases (2%), 1 case (2.3%) occurred in sclerosed pupil group and 1 case (4%) occurred in pseudoexfoliation. There was no statistically significant difference between the groups.

HYPHAEMA:

In our study hyphaema was noted in 6 cases (6%). There was 1 case (3.2%) in posterior synechiae group, 4 cases (16%) were in pseudoexfoliation group and it was statistically significant and 1 case (2.3%) in spasmodic pupil group. On comparison between groups there was proven statistical significance with $P < 0.05$ between groups with highest number of complications seen with PXF group.

The cause for hyphaema were direct iris trauma by instruments.

ANTERIOR CHAMBER COLLAPSE:

In our study AC collapse seen in 1 case (1%) and that case was also seen in sclerosed pupil group, which is statistically nil significant.

DIFFICULTY IN NUCLEUS DELIVERY:

In our study difficulty in nucleus delivery seen in 5 cases (5%). There were 3 cases (12%) in pseudoexfoliation group and 2 cases (4.5%) in sclerosed pupil group. On comparison between groups $P=0.12$ which is statistically not significant.

IRIDODIALYSIS:

In our study iridodialysis seen in 3 cases (3%). There was 1 case (3.2%) in posterior synechiae group, 1 case (4%) in PXF group and 1 case (2.3%) in sclerosed pupil group. On comparison between groups it was not significant with $P=0.92$. In all these cases it was grade-2 to 4 nucleus that posed a problem.

Peter and Kanas found superior dialysis occurring with phaco fragmentation technique with small pupil.

The iris must be reattached to the sclera by a series of nonabsorbable horizontal mattress sutures. Following the repair of the iridodialysis, the use of iris hooks or pupil-expanding devices may be helpful if pharmacologic dilation still fails to achieve an appropriate pupil size.

POSTERIOR CAPSULAR RENT WITH VITREOUS LOSS

In our study this complication is seen in 2 cases (2%) of which 2 cases (8%) were seen with PXF group. When compared between groups there was statistically significant difference with P value <0.05 , indicating significant difference in occurrence of this complication. Zonular instability increases the risk of lens subluxation, zonular dialysis or vitreous loss up to ten times⁷⁰. Vitreous loss in patients with pseudoexfoliation has been reported to be five times more common than in patients without this disorder (9.0% vs. 1.8%)⁷¹

POSTERIOR CAPSULAR RENT WITHOUT VITREOUS LOSS

In our study this complication is seen in 2 cases (2%) of which 2 cases (8%) were seen with PXF group. When compared between groups there was statistically significant difference with P value <0.05 , indicating significant difference in occurrence of this complication.

POST-OPERATIVE COMPLICATIONS:

STRIATE KERATOPATHY:

We noticed this complication in 11 cases (11%) of which 1 case (3.2%) seen with posterior synechiae group, 5 cases (20%) were seen with PXF group and 5 cases (11.4%) with sclerosed pupil group. There was no statistical difference between groups.

UVEITIS:

Mild to moderate uveitis was seen with 5 cases (5%) of which 1 case (3.2%) seen with posterior synechiae group, 2 cases (8%) seen with PXF group, and 2 cases (4.5%) seen with sclerosed pupil group. there was no statistical difference between groups. Intraoperative iris manipulations may lead to severe postoperative fibrinoid reaction especially in eyes with pseudoexfoliation syndrome, chronic uveitis, glaucoma or diabetes. That is why cataract surgery in the presence of a small pupil remains one of the most difficult and challenging cases.

HYPHAEMA:

Post operative hyphaema was seen in 3 cases (3%) of which 1 case (3.2%) was seen with posterior synechiae group, one case (4%) seen with PXF group and 1 case with (2.3%) sclerosed pupil group. There was no statistical significance between groups.

ATONIC PUPIL:

Post operative atonic pupil was seen with 11 cases (11%) of which 4 cases (12.9%) were seen with posterior synechiae group, 2 cases (8%) seen with PXF group and 5 cases (11.4%) seen with sclerosed pupil group. There was no statistical significance between groups.

In a study of stretch pupilloplasty by Dinsmore³⁴ 10% of 50 patients developed an enlarged atonic pupil postoperatively. All patients had a history of injury or inflammatory disease. Partial-thickness iris sphincter cuts made with micro scissors is a common pupil enlargement technique²⁷

The cutting method is more controlled but requires multiple maneuvers of the scissors inside the anterior chamber which can result in corneal endothelial damage. The disadvantages are permanent damage of sphincter muscle, bleeding and pigment dispersion postoperatively.

Birchall³⁵ assessed the effect on pupil shape and circumference of various flexible iris hook positions. He confirmed that malpositioned iris hooks may increase pupil stretching with possible deleterious effects on

postoperative pupil function. He recommends using additional fifth hook to create a pentagonal pupil that reduces pupil stretching by 17 %.

Masket³⁶ and Yaguchi and coauthors³⁷ recommend the pupil not be stretched by the hooks to larger than a 5.0 mm square because overstretching produces irregular atonic pupils postoperatively.

Halpern and coauthors³⁹ found an incidence of postoperative atonic pupil of 1.1 % after phacoemulsification, with pupil diameters ranging from 6.0 to 8.0 mm.

POST OPERATIVE VISUAL ACUITY:

In this study 1st post operative visual acuity was 6/6 in one case (1%), 6/9 in 34 cases (34%), 6/12 in 8 cases (8%), 6/18 in 43 cases (43%), 6/24 in 7 cases (7%) and 6/36 in 7 cases (7%).

Reduction in visual acuity in 1st post operative day was mainly due to corneal oedema, striate keratopathy and hyphaema.

In this study BCVA at the end of six weeks was 6/6 in 63 cases (63%), 6/9 in 23 cases (23%), 6/12 in 11 cases (11%), 6/18 in 2 cases (2%), and 6/24 in 1 case (1%).

One of the most important things in cataract surgery is pupil size. Unfortunately, many patients fail to show appropriate response to topical mydriatic agents, resulting in small, poorly dilated pupils, smaller than 4mm. Cataract surgery through small pupil is associated with a higher incidence of intra-operative complications such as capsular rupture, vitreous loss, dropped nucleus, endothelial loss and zonular dehiscence.

Many factors may cause small pupil. The most important causes are pseudo exfoliation (PXF) syndrome, chronic miotic therapy, previous trauma or surgery, uveitis with synechiae, diabetes mellitus, and recently the intra operative floppy iris syndrome (IFIS).

A study carried out in South India reported prevalence of PXF as 3.8%, while the Andhra Pradesh Eye Disease Study reported it as 3.01%.^{54,55} PXF induced iridopathy and phacopathy with zonular instability make routine cataract surgery a challenging task. Scroliet al⁷² found that such patients have 5 times greater risk of intraoperative complications in cataract surgery compared with normal cases. Recognition of this condition is very important before starting surgery on such patients.

Surgeons performing capsulorhexis in PXF may encounter capsule splitting phenomenon in which 2 or multiple layers of split capsule may be raised. The false anterior layer is typically fragile and tear abnormally compared with the underlying true anterior capsule. It is important to identify this phenomenon to allow complete incision of true capsule. A small capsulorhexis may lead to excessive pull on the zonules, difficulty in extracting nuclear material from capsular bag, increased risk of anterior capsular tear and higher incidence of post operative capsular phimosis. Excessive intra-operative manipulation cause post-operative corneal edema and iritis. In presence of weak zonules, it may lead to severe complications of lens subluxation and vitreous loss.

Other complications, some of which we encountered and which have also been reported in previous studies include iridodialysis, intraocular bleeding, vitreous loss. These are also related to difficult maneuvers due to small rigid pupils and zonular instability. Zonular fragility increases the risk of lens dislocation, zonular dialysis or vitreous loss upto 10 times.⁵⁰ Rate of vitreous loss varied from 0% to 11% across different studies.

Strategies to reduce stress on the zonules include avoidance of excessive fluctuations in the anterior chamber pressure by liberal use of viscoelastics and gentle maneuvers of lens especially gentle hydrodissection to allow unimpeded rotation of the nucleus. In cases with frank zonular weakness, use of a capsular tension ring that distributes forces circumferentially, also reduces post-operative IOLs decentration. Tangential stripping motion in the region of the defect may also reduce extension of the defect.

One study reported that an axial anterior chamber depth of less than 2.5 mm increased risk of surgical complications fivefold.⁵⁷

Intraoperative floppy iris syndrome is associated with increased risk of complications, In addition to all of the difficulties presented by a small pupil, intraoperative floppy iris syndrome (IFIS) provides further problems for the cataract surgeon. This syndrome was first described in association with current or prior tamsulosin (Flomax) use in 2005.⁵⁹ Besides poor preoperative pupil dilation, severe IFIS exhibits a triad of intraoperative signs: (1) iris billowing and floppiness, (2) iris prolapse to the incisions and (3) progressive intraoperative miosis. However, there is a wide range of clinical severity seen in clinical practice.

IFIS can be graded as mild (good dilation; some iris billowing without prolapse or constriction), moderate (iris billowing with some constriction of a moderately dilated pupil) or severe (classic triad and poor preoperative dilation).⁶⁰

In a prospective study of 167 eyes in patients taking tamsulosin, 10% had no IFIS, 17% mild IFIS, 30% moderate IFIS and 43% severe IFIS

A recent prospective, masked multicenter study demonstrated that tamsulosin, a selective alpha-1A blocker, is more likely to cause severe IFIS (34.3%) than alfuzosin (16.3%), a nonselective alpha-1 blocker that is also uroselective and less likely to cause postural hypotension.⁶³ A number of

retrospective and prospective studies have also shown that the frequency and severity of IFIS is much higher with tamsulosin than nonselective alpha-1 antagonists.^{61, 62, 64-66, 69}

The large retrospective Canadian study discussed earlier reported that tamsulosin significantly increased the rate of postoperative complications, but nonselective alpha antagonists did not.⁶⁴ A second Canadian retrospective study found that 86% of patients taking tamsulosin developed IFIS compared to only 15% of patients taking alfuzosin.⁶⁵

A prospective masked trial from Italy comparing phaco in patients taking tamsulosin versus nonselective alpha blockers and a large 2011 meta-analysis of the literature reached the same conclusion: that IFIS is more common and severe with tamsulosin.^{62,69} These and other studies were further supported by the 2008 ASCRS survey finding that 90% of respondents with sufficient experience believed that IFIS was more common with tamsulosin than with nonselective alpha-1 antagonists.[

The use of specialized adjunctive devices or techniques for widening small pupils grouped into one of the following categories mechanical viscomydriasis (Healon 5)^{44,47}; surgical (proximal iridectomy, pupillary membrane dissection, multiple partial sphincterotomies)⁴³; stretching (iris retractor hooks, bheeler pupil dilators, bimanual dilatation, silicon pupil expander, etc)⁴⁸, and ring expanders (PMMA pupil dilator ring, perfect pupil –polyurethane ring)^{43,48}.

The proper management of a small pupil for cataract surgery starts 2 days before surgery. On the operative day, the patient receives a regimen of phenylephrine 2.5%, cyclopentolate 1%, ketolorac 0.5%, given 10 minutes for three doses.

Intra-Operatively Non preserved epinephrine 0.5 mL in 500 mL of BSS is used for infusion during surgery, Intracameral epinephrine:1/3000 or 1/10000 or Intracameral lidocaine 1% can be used. Posterior synechiae: A “synechial ring” can be present. A high-viscosity viscoelastic like Healon 5 is then used to “viscodilate” the pupil.

Surgical methods to enlarge the pupil can be classified into, pupil stretching, iris cutting and iris retaining. Iris cutting usually involves a multitude of minisphincterotomies with either a pair of Vannas scissors or a retinal scissor. Over the last few years, several iris-retaining devices have come on the market. They come in one of two categories. First there are the iris retractors and. Second there are iris-retaining rings.

Novak³⁸ suggests the use of hooks with rigid pupils smaller than 3.0 mm (4.0 mm with a hard nucleus) and smaller than 4.0 to 5.0 mm for an inexperienced surgeon. In extremely small and rigid pupils he prefers combining the use of hooks with a radial sphincterotomy

When iris retractors fail then iris-retaining rings can be used; pupil dilator ring from Morcher (PMMA), Graether pupil dilator (silicone). Perfect Pupil device (polyurethane material). and The Malyugin Ring (5/0 polypropylene).

Advantage of iris retaining rings is maintaining pupil shape as well as sphincter function.

Halpern and coauthors³⁹ found an incidence of postoperative atonic pupil of 1.1 % after phacoemulsification, with pupil diameters ranging from 6.0 to 8.0 mm. Most of the surgical maneuvers for enlarging the pupil and preventing its intraoperative constriction are not safe enough. They can lead to an increased risk of iris sphincter tear, bleeding, iris damage, posterior capsule tears, and loss of the vitreous body.

The postoperative complications can include an atonic pupil of irregular shape with poor cosmetic result, and photophobia. The rate of occurrence of iris prolapse has been reported between 0.3 % and 1 % in complicated cataract cases⁴¹.

Use of specialized devices has increased the margin of safety and decreased the complications in these potentially complex cataract surgeries.

III. Conclusion

Small pupil with cataract presents challenges that requires careful preoperative planning and intraoperative care to ensure successful and safe surgery. The causes are numerous and can include iris sphincter sclerosis due to aging, synechiae, previous trauma or surgery, diabetes mellitus, chronic miotic therapy, iridoschisis, uveitis, pseudoexfoliation, and intraoperative floppy iris syndrome. The use of specialized adjunctive devices or techniques for widening small pupils can be grouped into one of the following categories; mechanical viscomydriasis (Healon 5)^{44,47}; surgical (proximal iridectomy, pupillary membrane dissection, multiple partial sphincterotomies)⁴³; stretching (iris retractor hooks, bheeler pupil dilators, bimanual dilatation, silicon pupil expander, etc)⁴⁸, and ring expanders (PMMA pupil dilator ring, perfect pupil –polyurethane ring)^{43,48}.

Use of specialized devices has increased the margin of safety and decreased the complications in these potentially complex cataract surgeries. Pupillary functions deteriorated more severely when larger pupillary enlargement was conducted intraoperatively. The patients whose pupils were stretched to larger than 25 mm² during surgery had significantly larger pupils postoperatively, with poorer reactions to light. On the

other hand, if a patient's pupil was enlarged to less than 25 mm², the pupillary area before the light stimulus was not significantly different from that of the normal controls, and the light reaction was preserved to a certain extent. It is presumed that excessive intraoperative pupillary dilation led to irregular and permanent damage of the sphincter muscle, causing oversized, nonreacting pupils after surgery.

The presence of posterior synechia before cataract surgery did not influence postoperative pupillary dynamics. This may be because the development of synechia has no relationship with the status of the iridial muscles per se. As for postoperative inflammation, it may be that eyes with small pupils required more complicated surgical maneuvers, leading to more intense postoperative inflammation and subsequent miosis.

Enlarging the pupil more than necessary will tear the sphincter, which may induce iris bleeding, alter the blood-aqueous barrier, and cause an atonic, chronically enlarged postoperative pupil. Consequences of the overly stretched and significantly damaged pupil include pupillary capture of IOL, chronic inflammation, pigmented and non pigmented deposits on the intraocular lens, and cystoid macular edema.

SMALL PUPIL WITH POSTERIOR SYNECHIAESMALL PUPIL WITH PSEUDOEXFOLIATION



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