

# Surgical outcomes of manual small incision cataract surgery in colobomatous eyes at a tertiary referral center: A prospective observational study

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## ABSTRACT

**Introduction:** Coloboma is a congenital ocular defect affecting various ocular structures and can make cataract surgery more challenging. Evidence on surgical outcomes from developing regions remains limited. This study evaluated the outcomes of manual small incision cataract surgery (M-SICS) in colobomatous eyes at a tertiary center. **Methods:** This prospective analytical study included 46 eyes with congenital coloboma and visually significant cataract managed at a tertiary referral center. Preoperative assessment included visual acuity, slit lamp examination, and biometry. The surgical technique was primarily M-SICS. Patients were followed on postoperative day 1, at 2 weeks, and 6 weeks. Outcomes assessed included visual acuity, intraoperative events, and postoperative complications. Statistical analysis included paired t-test and repeated measures ANOVA. **Results:** The mean age was 43.37±1.7 years, with 52.2% females. Bilateral involvement was present in 56.5%. Microcornea was observed in 39.1% and macula sparing coloboma in 65.2%. Preoperative mean visual acuity was 1.528±0.614 LogMAR, with 65.2% presenting with BCVA ≤1/60. Intraoperative challenges included poor pupillary dilatation in 45.7% and zonular weakness in 32.6%. Posterior capsular rent occurred in 23.9%. Intraocular lens implantation was achieved in 80.4%. Postoperatively, visual acuity improved significantly to LogMAR 0.996 on day 1, 0.720 at 2 weeks, and 0.696 at 6 weeks. Significant improvement was seen at all time points,  $p < 0.001$ . Good visual outcome was achieved in 58.7%. Corneal edema resolved by 6 weeks. **Conclusions:** M-SICS provides effective visual rehabilitation in colobomatous eyes despite intraoperative challenges.

**Keywords:** Cataract, cataract surgery, coloboma, microcornea, microphthalmia.

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## INTRODUCTION

Coloboma is a congenital ocular anomaly caused by incomplete closure of the embryonic fissure during early fetal development, and it can involve multiple ocular structures including the iris, lens, choroid, retina, and optic nerve.<sup>1</sup> These structural abnormalities often coexist with other ocular conditions such as microphthalmos, zonular weakness, and nystagmus, which increase the complexity of intraocular procedures.<sup>1,2</sup> Cataract formation in colobomatous eyes tends to occur at a younger age and is frequently associated with dense nuclear sclerosis, further complicating surgical management.<sup>2,3</sup>

Cataract surgery in eyes with coloboma presents unique intraoperative and postoperative challenges. Poor pupillary dilatation, lens subluxation, and associated anatomical anomalies increases the risk of complications such as capsulorrhexis extension, posterior capsular rent, vitreous loss, and corneal endothelial damage.<sup>3-6</sup> Several studies have evaluated surgical outcomes in such eyes using different techniques, including phacoemulsification (PE), extracapsular

cataract extraction (ECCE), and M-SICS.<sup>4,6,7</sup> These studies report variable visual outcomes, often influenced by factors such as macular involvement, preoperative visual acuity, and intraoperative complications.<sup>4,5,8</sup>

M-SICS remains a widely practiced technique in resource limited settings due to its cost effectiveness and adaptability to high volume surgical environments.<sup>7,9</sup> It has demonstrated comparable outcomes to phacoemulsification in selected cases, particularly in developing countries.<sup>10,11</sup> However, the presence of coloboma introduces additional surgical risks that may impact both anatomical and functional outcomes. Previous studies have highlighted the importance of careful case selection and intraoperative modifications to improve safety and visual prognosis.<sup>2,3</sup>

Despite this, there is limited data on surgical outcomes from developing regions. Lumbini Eye Institute and Research Center, a high-volume tertiary center serving a large population across the Indo-Nepal border, manages a substantial number of such cases, partly influenced by regional patterns of consanguinity. Evaluating outcomes in this setting provides relevant clinical evidence on the safety and effectiveness of M-SICS in colobomatous eyes, and helps define practical strategies to manage intraoperative challenges, minimize complications, and improve visual outcomes in similar settings. This study aimed to evaluate the surgical outcomes, intraoperative challenges, and postoperative complications of M-SICS in colobomatous eyes in a tertiary care setting.

## METHODS

This prospective analytical study was conducted for one year at Lumbini Eye Institute and Research Centre, a tertiary referral center serving the Indo-Nepal border population, from 1<sup>st</sup> May, 2023 to 30<sup>th</sup> April, 2024. Ethical approval was obtained from the Institutional Review Committee of LEIRC (Ref. No. 34/022/023), and written informed consent was obtained from all participants.

The study included 46 eyes of patients with clinically diagnosed congenital ocular coloboma and visually significant cataract. Consecutive eligible patients presenting during the study period were included using convenience sampling. Colobomas involving the iris, lens or zonules, choroid, or combined structures were eligible. Exclusion criteria included traumatic coloboma, associated retinal pathology unrelated to coloboma, prior intraocular surgery, uncontrolled systemic disease, and incomplete follow up.

All patients underwent detailed preoperative evaluation

including best corrected visual acuity (BCVA) assessment using Snellen or LogMAR charts, slit lamp biomicroscopy, intraocular pressure measurement, and dilated fundus examination. B scan ultrasonography was performed when posterior segment visualization was obscured. Axial length and keratometry were obtained using automated biometry, and intraocular lens power was calculated using the SRK-T formula. Grading of visual impairment was performed according to the International Council of Ophthalmology (ICO) classification<sup>12</sup>, and cataracts were graded using the Lens Opacities Classification System-III.<sup>13</sup> Coloboma characteristics including type<sup>1</sup>, extent, optic disc involvement, microcornea, zonular deficiency, and fundus coloboma grade were documented in a standardized proforma.

All surgeries were performed under peribulbar anesthesia by experienced consultant cataract surgeons. M-SICS was the primary technique in all cases. Intraoperative findings including zonular dialysis, lens subluxation, capsulorrhexis extension, posterior capsular rupture, vitreous loss, and intraocular lens stability were recorded. Surgical modifications such as capsular tension rings, iris hooks, viscoelastic devices, and careful nucleus management were employed as required.

Postoperative follow up was conducted on day 1, week 2, and week 6. Assessments included best corrected visual acuity, anterior segment examination, intraocular pressure, fundus evaluation, and intraocular lens position. Postoperative complications including corneal edema, hyphema, descemet membrane detachment, raised intraocular pressure, retinal detachment, and intraocular lens decentration were documented.

Selection bias was minimized by consecutive sampling, and measurement bias was reduced through standardized examination protocols and uniform follow up. Data were recorded in a structured proforma and analyzed using IBM SPSS Statistics version 27. Continuous variables were expressed as mean with standard deviation, and categorical variables as frequencies and percentages. Changes in visual acuity were assessed using paired sample t test, and repeated measures ANOVA was used to evaluate the effect of time. A p-value < 0.05 was considered statistically significant.

## RESULTS

Demographics and baseline characteristics:

Forty-six eyes with colobomatous malformations were

included, that underwent M-SICS following standard surgical protocol. The cohort comprised more females 24(52.2%) than males 22(47.8%). The mean age of patients was 43.37±1.7 years with a range of 19–67years. Bilateral coloboma occurred in 26(56.5%) patients, unilateral in 17(36.99%) (right: 8, left: 9), and 3(6.5%) patients had only one functional eye. Consanguinity was noted in 14(30.4%) patients. (Table 1)

**Table 1:** Demographic and baseline characteristics in eyes of patients with Colobomatous cataract undergoing M-SICS (N=46)

Variable	Category / Value	Frequency (n)	Percentage(%)
Gender	Female	24	52.2
	Male	22	47.8
Laterality	Bilateral	26	56.5
	Right	9	19.6
	Left	8	17.4
Consanguinity	One-eyed	3	6.5
	Yes	14	30.4
Age (in years, Mean ± SD)	No	32	69.6
		43.37 ± 1.7	

**Ocular characteristics:**

Microcornea was present in 18(39.1%) eyes, microphthalmos in 5(10.9%), nystagmus in 14(30.4%), and shallow anterior chamber depth in 12(26.1%). Mean corneal diameter was 9.56±1.24 mm and mean axial length 23.04±2.99 mm. Coloboma type III was most frequent seen in 24(52.2%), and the macula was spared in 30(65.2%) eyes. (Table 2)

**Table 2:** Ocular characteristics and keratometric values in eyes of patients with Colobomatous cataract undergoing M-SICS (N=46)

Variable	Category / Value	Frequency (n)	Percentage (%)
Microcornea	Yes	18	39.1
	No	28	60.9
Microphthalmos	Yes	5	10.9
	No	41	89.1
Nystagmus	Yes	14	30.4
	No	32	69.6
Shallow AC depth	Yes	12	26.1
	No	34	73.9
Corneal diameter (mm, Mean ± SD)		9.56 ± 1.24	-
Corneal diameter grading	Grade 1	7	15.2
	Grade 2	11	23.9
	Grade 3	28	60.9
Axial length (mm, Mean ± SD)		23.04 ± 2.99	-
Axial length grading	<21 mm	9	19.6
	21–25 mm	29	63.0
	>25 mm	8	17.4
Type of coloboma	Type I	16	34.8
	Type II	2	4.3
	Type III	24	52.2
	Type IV	2	4.3
	Type V	2	4.3
Macula involvement	Involving	16	34.8
	Sparing	30	65.2

AC: Anterior chamber, SD: Standard Deviation

**Cataract characteristics and preoperative status**

Soft cataracts (NS grades I–III) predominated in 34(73.9%) eyes. Preoperative visual acuity ranged from LogMAR 0.5 to 2.7 (mean 1.528±0.614), with 30 eyes (65.2%) presenting with BCVA ≤1/60 (Near blind). IOL implantation was performed in 37 eyes (80.4%) with a mean power of 19.34 ± 5.17 D. (Table 3)

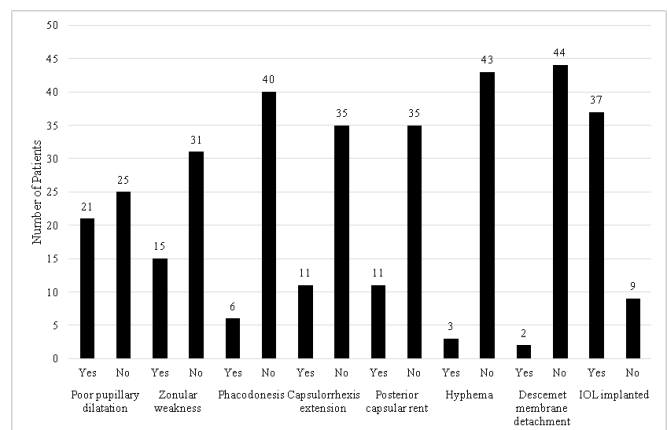
**Table 3:** Cataract characteristics and preoperative status in eyes of patients with Colobomatous cataract undergoing M-SICS (N=46)

Variable	Category / Value	Frequency (n)	Percentage (%)
Cataract type [13]	Soft (NS I–III)	34	73.9
	Hard (NS IV–VI)	12	26.1
Preoperative BCVA	Mean ± SD (Log-MAR)	1.528 ± 0.614	-
	Moderate (6/18–6/60)	11	23.9
Preoperative ICO grading of Visual Impairment	Severe (6/60–3/60)	2	4.3
	Profound (2/60)	3	6.5
IOL power implanted (D)	Near blind (≤1/60)	30	65.2
	Mean ± SD (n=37)	19.34 ± 5.17	-

SD: Standard Deviation, ICO: International Council of Ophthalmology, NS: Nuclear Sclerosis, BCVA: Best Corrected Visual Acuity, IOL: Intra Ocular Lens, D: Dioptre

**Intraoperative events and complications:**

The most frequent intraoperative challenges were poor pupillary dilation (21 eyes, 45.7%) and zonular weakness (15 eyes, 32.6%). Capsulorrhexis extension and posterior capsular rent occurred in 11 eyes each (23.9%), while phacodonesis, hyphema, and descemet membrane detachment were less common. IOL implantation succeeded in 37 eyes (80.4%). (Figure 1)



**Figure 1:** Types of intraoperative events; (IOL: Intra Ocular Lens)

**Post-operative outcomes and complications**

Visual acuity improved steadily from 1.528±0.614 LogMAR

preoperatively to 0.996±0.792 LogMAR on post-operative day one, 0.720±0.656 LogMAR at two weeks post-operatively, and 0.696±0.664 LogMAR at six weeks post-operatively. Corneal edema resolved by six weeks, present in 56.5% on day one and 10.9% at two weeks. Overall, 27 (58.7%) eyes achieved good visual outcome, while 19(41.3%) had poor outcome. (Table 4)

**Table 4:** Postoperative outcomes and complications in eyes of patients with Colobomatous cataract undergoing M-SICS (N=46)

Variable	Category	Post-operative Day 1	Post-operative week 2	Post-operative week 6
BCVA (LogMAR, mean ± SD)		0.996 ± 0.792	0.720 ± 0.656	0.696 ± 0.664
Corneal edema	Yes	26 (56.5%)	5 (10.9%)	0 (0%)
	No	20 (43.5%)	41 (89.1%)	46 (100%)
Visual Outcome at 6 weeks post-operatively	Good visual outcome	27 (58.7%)		
	Poor visual outcome	19 (41.3%)		
Postoperative ICO grading of visual impairment [12] at 6 weeks post-operatively (N=46)	Mild (>6/18)	27		
	Moderate (6/18–6/60)	2		
	Severe (6/60–3/60)	2		
	Profound (2/60)	4		
	Near blind (≤1/60)	11		

SD: Standard Deviation, ICO: International Council of Ophthalmology, BCVA: Best Corrected Visual Acuity

**Visual acuity analysis**

Paired t-tests showed significant improvement at all postoperative points compared to baseline: Day 1 (mean difference 0.533, p <0.001), 2 weeks (0.809, p <0.001), 6 weeks (0.833, p <0.001). (Table 5) Repeated measures ANOVA confirmed a significant time effect on visual acuity (F=63.932, p <0.001, partial η<sup>2</sup> = 0.587) with a linear improvement pattern (F=104.603, p <0.001). (Table 6)

**Table 5:** Paired t-test for visual acuity improvement (LogMAR values) compared among pre-operative BCVA with BCVA at post-operative day 1, week 2 and week 6 pairwise

Comparison	Mean Difference	T	df	p-value
BCVA- pre-operative vs post-operative day 1	0.533	6.471	45	<0.001*
BCVA- pre-operative vs post-operative week 2	0.809	10.167	45	<0.001*
BCVA- pre-operative vs post-operative week 6	0.833	10.402	45	<0.001*

T: t-statistics, df: Degree of freedom; \* p<0.05 denotes statistical significance

**Table 6:** Repeated measures ANOVA for LogMAR vision compared among pre-operative BCVA with BCVA at post-

operative day 1, week 2 and week 6

Effect	F	df	P-value	Partial Eta Squared
Time	63.932	3	<0.001	0.587
Linear contrast	104.603	1	<0.001	0.699
Quadratic contrast	34.082	1	<0.001	0.431
Cubic contrast	0.001	1	0.980	<0.001*

F: F-statistics of ANOVA, df: Degree of freedom; \* p<0.05 denotes statistical significance

**DISCUSSION**

Cataract surgery in colobomatous eyes is technically challenging due to structural abnormalities that affect both intraoperative course and postoperative recovery. In this study, most patients presented in the fourth decade with severe visual impairment, and a large proportion had bilateral disease. This pattern reflects the early onset and progressive nature of cataract formation in such eyes, as reported in earlier studies.<sup>2,3</sup> The presence of consanguinity in nearly one third of patients further supports its known association with congenital ocular anomalies.<sup>1</sup>

Associated ocular abnormalities were common in this cohort, including microcornea, microphthalmos, and nystagmus. These findings align with established descriptions of coloboma as a complex developmental disorder involving multiple ocular structures.<sup>1,2</sup> Zonular instability and reduced anterior chamber depth observed in a subset of eyes are clinically relevant, as they directly influence surgical planning and intraoperative stability.

Most eyes had soft to moderately dense cataracts, although a significant proportion presented with advanced visual loss. The predominance of BCVA ≤ 1/60 (Near blind) at presentation highlights delayed healthcare access and late surgical uptake in this population. Similar trends have been documented in developing settings, where socioeconomic and geographic barriers influence disease presentation.<sup>10,15</sup>

Intraoperative challenges were frequent. Inadequate pupillary dilation and zonular weakness were the most common findings, followed by capsulorrhexis extension and posterior capsular rent. These observations are consistent with previous reports that describe increased surgical complexity in colobomatous eyes due to altered anatomy and compromised zonular support.<sup>3-5</sup> The rate of posterior capsular rent in this study is comparable to earlier series, reinforcing the need for careful nucleus management and capsular handling.

Despite these challenges, intraocular lens implantation was achieved in the majority of cases. This reflects the feasibility

of M-SICS in such eyes when appropriate intraoperative modifications are applied. Existing literature emphasizes the role of tailored surgical strategies, including the use of viscoelastic support, controlled capsulorrhexis, and careful nucleus delivery.<sup>3,4</sup>

A consistent improvement in visual acuity was observed across all postoperative time points. Mean LogMAR vision improved significantly from baseline to 6 weeks, with a clear linear trend on repeated measures analysis. These findings indicate that meaningful visual rehabilitation is achievable even in anatomically complex eyes. Similar improvements have been reported in both phacoemulsification and M-SICS series, suggesting that surgical technique, when appropriately adapted, can yield favorable outcomes.<sup>6,11,14</sup>

However, visual outcomes showed variability. While a majority of eyes achieved good visual outcome, a substantial proportion continued to have suboptimal vision. This variation can be explained by underlying structural factors. Final visual acuity is largely determined by baseline vision and the status of the posterior segment, particularly macular involvement. Eyes with macula sparing coloboma are known to have better prognosis, while those with macular involvement often have limited visual potential despite successful surgery.<sup>4,6</sup>

Postoperative recovery was generally favorable. Corneal edema was common on the first postoperative day but resolved in most cases by two weeks and completely by six weeks. This transient edema is likely related to surgical manipulation and endothelial stress, and its resolution indicates satisfactory corneal recovery. The absence of long-term corneal complications supports the safety of the surgical approach used.

The findings of this study are in agreement with trends reported in earlier studies from similar settings. M-SICS continues to be extensively used in centers managing a large surgical workload due to its cost effectiveness and adaptability. Several comparative studies have shown similar visual results to phacoemulsification in selected cases, particularly in dense cataracts and complex anatomy.<sup>7-9,11,14</sup> In this context, the present study adds evidence supporting its utility in colobomatous eyes.

At the same time, the relatively high rate of intraoperative events highlights the importance of surgical expertise. Meticulous preoperative assessment and operative planning are critical to optimize results. Identifying zonular weakness, assessing pupil dynamics, and anticipating potential complications allow surgeons to adopt appropriate

modifications and reduce risk.

The study provides clinically relevant insights from a high-volume tertiary center serving a diverse population. However, interpretation of the findings should consider certain constraints. The sample size is modest and the follow up period is limited to six weeks, which may not capture long term outcomes such as posterior segment complications or late intraocular lens instability. Future studies with larger cohorts, longer follow up, and stratified analysis based on coloboma type and macular status would help refine prognostic assessment and guide surgical decision making.

## CONCLUSIONS

Cataract surgery in colobomatous eyes is associated with increased intraoperative complexity but can achieve meaningful visual improvement. This study demonstrated that M-SICS is a safe and effective option for managing cataracts in colobomatous eyes in a tertiary care setting. However, careful case selection, surgical expertise, and appropriate intraoperative modifications are critical to achieving favorable outcomes.

## DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**CONFLICTS OF INTEREST:** None declared

**SOURCE OF FUNDING:** None

## AUTHORS' CONTRIBUTIONS

AS and SP conceptualized the study. AS contributed in data collection, data analysis and preparation of manuscript. AS, SP and AT reviewed and edited the manuscript. All authors approved the final manuscript. All authors had complete access to the study data.

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