Original Article

Safety and efficacy of manual small-incision cataract surgery in patients with brunescent and black cataracts and other ocular comorbidities

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Purpose: To determine the safety and efficacy of manual small-incision cataract surgery (MSICS) for brunescent and black cataracts in patients with other ocular comorbidities. **Methods:** Medical records of patients with hard cataracts (grade 4 nuclear opalescence and above) with other ocular comorbidities such as spheroidal degeneration of the cornea (SDC), pseudoexfoliation (PXF), non-dilating pupil, and high myopia who underwent MSICS were retrieved retrospectively. Intraoperative and postoperative complications were noted. Preoperative and postoperative visual outcome comparisons were performed using paired t-tests. Statistical significance was set at $P < 0.05$. **Results:** A total of 124 cataract patients with brunescent or black cataracts and other ocular comorbidities underwent surgery during the study period. They ranged in age from 56 to 89 years (mean: 68.9 + 11.9 years), with 55.66% ($n = 69$) of the patients being female and 44.35% ($n = 55$) male. Of the 124 cases, 45.16% ($n = 56$) had SDC, 31.45% ($n = 39$) had PXF, 14.51% ($n = 18$) had non-dilating pupils, and 8.87% ($n = 11$) had high myopia. Preoperatively all patients had visual acuity <6/60. At 1 month postoperatively 77.4% of patients achieved good vision >6/18, 16.9% had a borderline vision (6/18–6/60), and 5.6% had a poor vision (<6/60). No serious complications were observed. One patient had posterior capsular rent in a case of high myopia, and two cases had zonular dialysis for pseudoexfoliation. **Conclusion:** MSICS with intraocular lens implantation is safe and effective in eyes with brunescent/black cataracts if associated with SDC, PXF, high myopia, and non-dilating pupils and provides good visual outcomes with minimal complications.

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Cataract surgery for brown or black cataracts is challenging. Phacoemulsification surgery for brunescent and black cataracts is associated with a higher incidence of corneal endothelial cell loss and intraoperative complications.[1] It can be extremely challenging if the patient has other ocular comorbidities such as corneal degeneration,[2] small non-dilating pupil,[3] pseudoexfoliation (PXF),[4] and high myopia.[5]

Small-incision cataract surgery (SICS) appears to be safe in patients with brunescent and black cataracts and ocular comorbidities.[6] We aimed to determine the safety and efficacy of SICS for brunescent and black cataracts in patients with other ocular comorbidities from a tribal population in Rajasthan.

Methods

Medical records of patients with hard cataracts (grade 4 nuclear opalescence and above) who underwent SICS between October 2021 and December 2021 at our institution were retrieved retrospectively. Only patients with hard brown cataracts and other ocular comorbidities such as spheroidal degeneration of the cornea (SDC), PXF, non-dilating pupil, and high myopia were included. Patients with follow-up for less than 3 months and an intraocular pressure (IOP) >20 mm Hg were excluded from the study.

Informed written consent was obtained from all participants before surgery. Due to the nature of the patients' cataracts, their visual prognosis was considered potentially limited. Ultrasonography B was performed to rule out any retinal pathology. The cataract was diagnosed using slit-lamp biomicroscopy and graded using clinical observation based on a scale from 1 to 4. Rock hard cataract was defined as either grade 4, brown cataracts, or cataract nigra as per the Lens Opacities Classification System, classification 3.[7]

SDC was defined as amber-colored granules in the superficial stroma of the central cornea, with nodules and surrounding stromal haze.[8]

PXF was diagnosed before and after dilatation of the pupil as a grayish-white fibrillary material deposited on various ocular structures.[9]

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Non-dilating pupils were eyes with a pupillary diameter <6 mm preoperatively after dilating the drop. High myopia was defined as patients with an axial length >26 mm.

All surgeries were performed by two surgeons (AM and MG) using the standard technique of SICS with superior or superotemporal sclerocorneal tunnel, larger continuous curvilinear capsulorhexis rhexis (>6.5 mm) nucleus delivery with irrigating Vectis, in-the-bag intraocular lens (IOL) implantation, and wound closure with hydration. The surgeons used 2% hydroxypropyl methylcellulose (Viscomet) and irrigation with a balanced salt solution in all patients. Intracameral adrenaline (1:10,000) was used in all patients to prevent intraoperative miosis. Intraoperative difficulties and complications were recorded.

This study followed the principles of the Declaration of Helsinki, and ethical approval was obtained from the institutional ethics committee.

The postoperative topical drug regimen included a combination of tobramycin and dexamethasone eye drops six times a day for a week, followed by weekly tapering over the next 6 weeks and Homatropine 1% eyedrops twice a day for one week.

Postoperatively, the eyes were examined after 1 day, 1 week, 1 month, and 3 months. Slit-lamp biomicroscopy and fundus evaluation were performed at each visit for wound integrity, corneal edema, anterior chamber cells and flares, pupil, and IOL position. Visual acuity was assessed using the Snellen chart, and intraocular pressure (IOP) was recorded using a non-contact tonometer (NCT) at all visits. Goldman applanation tonometry (GAT) was used for measuring IOP in patients with an IOP >20 mm Hg on NCT and a C:D ratio >0.3.

Postoperative complications if any were noted. Corneal edema is defined as the number of Descemet's fold >5. Heightened postoperative inflammation is defined as cells >2 on slit-lamp examination. An IOP >22 mm Hg was considered as raised IOP.

Uncorrected visual acuity (UCVA) and best-corrected visual acuity (BCVA) were tested and classified according to the World Health Organization (WHO) recommendations. Visual acuity was converted to logMAR values for statistical analysis. The difference between preoperative and one-month postoperative mean visual acuity was calculated. Preoperative and postoperative visual outcome comparisons were performed using paired t-tests. A significance value (*P* value) and 95% confidence interval (CI) of the difference were reported. Statistical significance was set at $P < 0.05$.

Descriptive statistical analysis was performed for the other variables and is presented as a number (%). SPSS version 15.0 (SPSS for Windows, version 15.0, Chicago, SPSS Inc.) was used to analyze the data. Microsoft Word and Excel were used to generate the graphs and tables.

Results

A total of 124 cataract patients with brunescent or black cataracts and other ocular comorbidities underwent surgery during the study period. They ranged in age from 56 to 89 years (mean: 68.9 + 11.9 years), with 55.66% (n = 69) of the patients being female and 44.35% (n = 55) male. Of the 124 cases, 45.16% (n = 56) had SDC, 31.45% (n = 39) had PXF, 14.51% (n = 18) had non-dilating pupils (other than PXF), and 8.87% (n = 11) had high myopia. Table 1 summarizes the demographic details of the patients.

Intraoperative/postoperative complications and visual outcomes

Spheroidal degeneration of the cornea

A total of 56 patients with brunescent or black cataracts with SDC were included. The mean preoperative BCVA was 2.3 + 0.67 logMAR which improved to 0.4 + 0.22 logMAR by the one-month follow-up visit ($P < 0.0001$). According to the WHO classification, of the 56 patients who underwent cataract surgery, 6.7% (n = 4) had visual outcomes between 6/24 and 6/60; 30% (n = 17) had visual outcomes between 6/12 and 6/24, and the remaining 63.3% (n = 35) had visual outcomes between 6/6 and 6/12. Four cases had a low vision due to extensive corneal degeneration with involvement of the central cornea.

Intraoperatively, three patients had anterior capsulorhexis-related problems because of poor visibility due to extensive corneal degeneration, but none had any serious or sight-threatening complications. None of the patients underwent zonular dialysis (ZD) or posterior capsular rent (PCR). Three patients had corneal edema on postoperative day one that resolved in the subsequent follow-up period. Two patients had heightened postoperative inflammation on day one, which resolved with routine postoperative medication within 1 week.

Pseudoexfoliation

A total of 39 patients with brunescent or black cataracts and PXF underwent surgery. Patients with a high IOP before surgery were excluded. The mean preoperative visual acuity was 2.1 + 0.73 logMAR which improved to 0.31 + 0.27 logMAR by the one-month follow-up visit ($P < 0.0001$). Intraoperatively, two patients had ZD. One patient had ZD of less than three clock hours, and a three-piece IOL was implanted in the bag. The other patient had ZD of more than six clock hours with total bag weakness and was left aphakic in the primary sitting. They underwent sutured scleral fixation of the IOL at 1 month with a BCVA of 6/12 at 3 months.

Two patients had corneal edema, one patient had heightened postoperative inflammation on day one, and two patients had raised IOP at 1 month (probably one was a steroid responder, and one had pseudoexfoliation (PXF) glaucoma).

Table 1: Demographic data and clinical characteristics of patients

Variables	*n* (%)
Total no of brunescent/black cataract	124
Mean Age (min-max) in years	68.9+11.9 years (56-89)
Sex	
Male	55 (44.35%)
Female	69 (55.66%)
Comorbidities	
Spheroidal degeneration of the cornea	56 (45.16%)
Pseudoexfoliation	39 (31.45%)
Non-dilating pupil	18 (14.51%)
High Myopia	11 (8.87%)

No sight-threatening complications were observed in any of these patients at 3 months.

Non-dilating pupil

Eighteen patients with brunescent and black cataracts with a pupillary diameter <6 mm underwent surgery. The mean preoperative visual acuity was 2.2 + 0.83 logMAR which improved to 0.15 + 0.11 logMAR at 1 month postoperatively. All patients had a BCVA >6/12 at 1 month postoperatively. Intraoperatively, two patients required multiple sphincterotomies of the iris before capsulorhexis, and one patient had a traumatized superior iris.

None of the patients had any intraoperative complications such as PCR, ZD, or no IOL. Two patients had corneal edema on day one, and four had heightened postoperative inflammation. One patient had superior optic capture of the IOL at 1 month, which was managed conservatively.

High myopia

Eleven patients with brunescent or black cataracts and high myopia underwent surgery. The mean preoperative visual acuity was 2.3 + 0.81 logMAR which improved to 0.57 + 0.33 logMAR at the 1 month of follow-up. Five patients had BCVA >6/24, three had <6/24 to 6/60, and three had <6/60. Postoperatively, three patients had low vision because of myopic maculopathy.

Intraoperatively, one patient encountered PCR, in which anterior vitrectomy was performed with a vitrector, and a three-piece IOL was implanted in the sulcus. Postoperatively, none of the patients had complications except one who had corneal edema at the follow-up visits on day one and week one, which resolved in subsequent follow-up. Fig. 1 shows a postoperative day 1 photo of a high myopic patient with black cataract.

Table 2 shows the postoperative visual outcome at 1 month in different ocular morbidities.

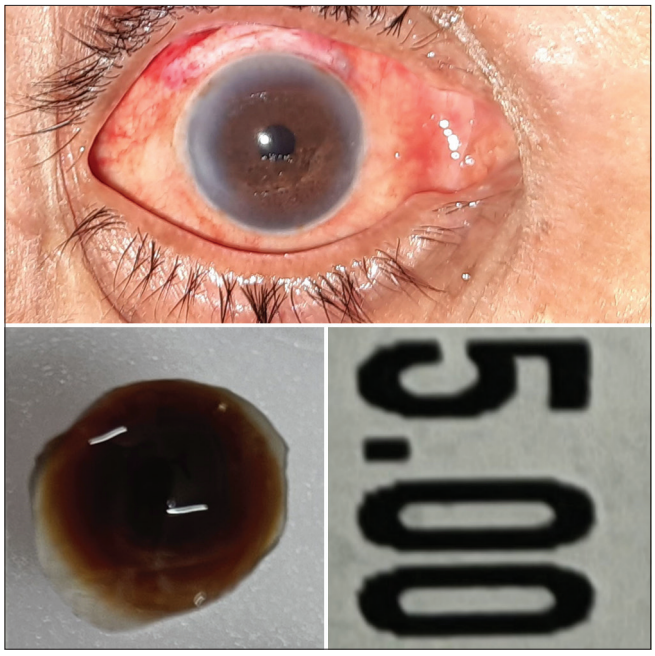

Figure 1: 1st postoperative day image of an eye with a black cataract with an IOL power of +5.0 D

Table 3 shows the intraoperative and postoperative complications in brunescent and black cataract with different ocular comorbidities.

Discussion

Several surgical techniques are considered for brunescent or black cataracts, including extracapsular cataract extraction (ECCE), SICS, phacoemulsification, and Femto laser-assisted cataract surgery. Each surgical technique has its own advantages and disadvantages, and which one is better for these types of cataracts depends on surgeon comfort, availability of advanced surgical instruments, and availability of vitreoretinal surgeons for support, if required.[1] With modern machines, techniques, and viscosurgical devices, phacoemulsification is a safe technique even in hard cataracts.[10] To achieve good outcomes in phacoemulsification of hard cataracts, endocapsular emulsification is required, which may be difficult and sometimes risky because of the incomplete division of nuclear fragments, which are held together as central plate-like flower petals.[10] However, many ophthalmic surgeons are hesitant to perform phacoemulsification in hard brown or black cataracts and instead use ECCE.[11] SICS is a cheap and good alternative to phacoemulsification and provides better visual outcomes than ECCE.[12]

In our cataract population from Rajasthan, hard brunescent and black cataracts were common. In this study, we assessed the safety and visual outcomes of SICS in 124 eyes with hard cataracts and other ocular comorbidities. The results of our study show that SICS is safe for hard cataracts. No serious complications were observed in any of the cases. Only one patient underwent PCR in one case of high myopia and two cases of ZD for pseudoexfoliation. Muhtaseb *et al*.[13] studied the risk factors associated with intraoperative complications during phacoemulsification and found that brown/black cataracts are an independent risk factor for PCR, ZD, and nucleus or fragment drops. None of the patients in our series had a nucleus or fragment drop. In a study by Venkatesh *et al*.,[14] two patients underwent PCR for 102 brunescent cataracts that were treated with SICS, similar to our results.

Eight eyes (6.45%) in our study developed transient corneal edema that lasted for <2 weeks. All patients had superior corneal edema with a clear central cornea. The reported incidence of endothelial cell loss after phacoemulsification in patients with brunescent/black cataracts is very high. In a study on phacoemulsification in eyes with brown or black cataracts by Singh *et al*.,[15] 28.1% developed corneal edema, in contrast to 6.45% of eyes in the current study. In a study on SICS in brunescent cataracts by Venkatesh *et al*.,[14] 14.7% (n = 15) developed corneal edema with DM folds >10. After phacoemulsification, the reported incidence of wound site thermal injury was 13% in brown cataracts.[15] Ophthalmic viscosurgical devices (OVDs) containing chondroitin sulfate are the better viscoelastic for grade 4 and above cataract for corneal endothelial protection, though we have not used it in our cases.

Two patients in our study had increased IOP postoperatively, and both were in the PXF group. One patient was a steroid responder who responded well after steroid tapering, whereas the other had PXF glaucoma. Krupin *et al*.[16] proposed that hard cataract eyes are predisposed to glaucoma, probably because of a compromised outflow facility that cannot tolerate

Table 2: Preoperative and postoperative visual acuity following SICS in brunescent and black cataract with different ocular comorbidities

Visual acuity range	Preoperative visual acuity (BCVA)				Postoperative visual acuity (BCVA) at 1 month			
	Spheroidal degeneration of cornea (*n*)	Pseudo Exfoliation (*n*)	Non-dilating pupil (*n*)	High Myopia (*n*)	Spheroidal degeneration of cornea (*n*)	Pseudo Exfoliation (*n*)	Non-dilating pupil (*n*)	High Myopia (*n*)
PL±3/60	44	31	15	9	0	0	0	0
3/60-6/60	12	8	3	2	4	0	0	3
6/60-6/18	0	0	0	0	17	1	0	3
6/18-6/12	0	0	0	0	31	12	0	4
>6/12	0	0	0	0	4	26	18	1

Postoperative visual outcome as per the WHO Classification in all subgroups at 1 month

Category	BCVA	Number (%)
Good	>6/18	96 (77.4%)
Borderline	6/18-6/60	21 (16.9%)
Poor	<6/60	7 (5.6%)

Mean preoperative and postoperative vision in different groups

Group	Preoperative vision (Mean+SD) log MAR	1-month postoperative BCVA (Mean+SD) log MAR	Difference	95%CI	*P*
Spheroidal degeneration of the cornea	2.3+0.67	0.4+0.22	−1.9	−2.08 to-1.71	<0.0001
Pseudoexfoliation	2.1+0.73	0.31+0.27	−1.79	−2.03 to-1.54	<0.0001
Non-dilating pupil	2.2+0.83	0.15+0.11	−2.05	−2.45 to-1.64	<0.0001
High myopia	2.3+0.81	0.57+0.33	−1.73	−2.28 to-1.17	<0.0001

Table 3: Intraoperative and postoperative complications

	Number (%)				
	SDC (*n*=56)	PXF (*n*=39)	Non-dilating pupil (*n*=18)	High Myopia (*n*=11)	Total (*n*=124)
Intraoperative complications					
PCR	0	0	0	1	1 (0.81%)
Zonular Dialysis	0	2	0	0	2 (1.6%)
NO IOL	0	1	0	0	1 (0.81%)
Iris trauma	0	0	1	0	1 (0.81%)
Postoperative complications Day-1					
Corneal edema	3	2	2	1	8 (6.45%)
Heightened postoperative inflammation	2	1	4	0	7 (5.64%)
Raised IOP	0	2	0	0	2 (1.61%)
Pupillary abnormality	0	0	2	0	2 (1.61%)
IOL-related complications	0	0	0	0	0
Postoperative complications 1 month					
Corneal edema	0	0	0	0	0
Heightened postoperative inflammation	0	0	0	0	0
Raised IOP	0	2	0	0	2 (1.61%)
Pupillary abnormality	0	0	2	0	0
IOL-related complications	0	0	0	0	0

surgical trauma of phacoemulsification with a higher incidence of raised IOP.

Seven patients in our study had temporarily heightened postoperative inflammation in the first week of surgery, and most were in the small pupil group. Poor mydriasis may result in more iris touch during nucleus prolapse in the anterior chamber, leading to inflammation in the early postoperative period, which responds well to topical steroids. Small pupil phacoemulsification is also a known risk factor for postoperative uveitis.[17]

The prevalence of SDC is quite high in the southwestern part of Rajasthan because of very low rainfall, hot winds, and dust

storms in summer.[8] In our study, 56 patients had SDC. The ideal treatment for these patients is penetrating keratoplasty with cataract extraction and IOL implantation. However, the lack of functional eye banks in this region and good-quality corneal donor tissue limit corneal transplantation. Therefore, only SICS with IOL remains a good option for compromised corneas so that patients can at least gain the minimal vision to perform activities of daily living. We observed an improvement in visual acuity in 92.85% (n = 52) of our patients. This result was similar to that of a study by Kusumesh *et al*.,[18] who found a significant improvement in postoperative visual acuity in two-thirds of their patients after SICS alone from baseline to 0.76 logMAR.

In our study, the frequency of PXF in patients with hard brown or black cataracts was 31.45% (n = 39), which is similar to that reported by Govetto *et al*.[19] ZD was encountered in two PXF cases in our study. This complication is expected in eyes with PXF and a harder nucleus. However, this complication can be easily managed by the implantation of capsular tension rings (CTRs) if ZD is less than two quadrants in extent and by capsular tension segment in larger ZD. Joshi *et al*.[20] reported the incidence of zonular dehiscence in 8% of patients. Furthermore, in a study by Shastri *et al*.,[21] 2.2% of eyes converted to SICS from phacoemulsification in PXF.

In the present study, 11 eyes with brunescent/black cataracts had high myopia. Several population-based researchers found a four-fold increased risk of nuclear cataracts in patients with high myopia exceeding 5.00 D.[22,23] We have included patients with axial length >26 mm in the high-myopia group. Cataract surgery is challenging in myopic eyes with brunescent cataracts. The incidence of PCR and no IOL was very high in myopic patients during phacoemulsification. Brown cataracts make this situation even more challenging because of the retropulsion of the iris diaphragm, leading to the incomplete division of the nucleus and more complications. In our series, only one patient underwent PCR with an IOL in the sulcus. Most patients with high myopia had vision between 6/18 and 6/6. The results were better in our study than in studies conducted in Korea and Shanghai.[24,25]

A small pupil is a known risk factor for many complications during cataract surgery. Inappropriate preoperative mydriasis or intraoperative miosis can result in difficult phacoemulsification. There was a two-fold increase in vitreous loss in the patients with inadequate pupil dilation.[26] In our series of small pupils, none of the patients underwent PCR. However, four patients had increased postoperative inflammation in these cases, which is acceptable, as discussed by Malyugin.[17] We performed multiple sphincterotomies with fine scissors in two cases, but none of them developed photophobia after surgery. Controlled sphincterotomy with microscissors is recommended in such patients to avoid extensive sphincter tears.[3] Intraoperative use of iris hooks and pupil expansion devices like Malyugin ring are the standard of care for non-dilating pupils during cataract surgery.

The major strength of our study is that we analyzed the results of SICS in different types of ocular comorbidities in hard cataracts. This was a non-comparative retrospective interventional study. We have also not measured endothelial count either preoperative or postoperatively. Further prospective randomized comparative studies are warranted with comparisons of standard procedures or different techniques to confirm our findings.

Conclusion

Our data show that manual SICS with IOL implantation is safe and effective in eyes with brunescent/black cataracts if associated with SDC, PXF, high myopia, and non-dilating pupils. SICS with IOL implantation provides good visual outcomes with minimal complications.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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