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Original Research Article

Comparison of surgical technique and outcomes of phacoemulsification and manual small incision cataract surgery in management of phacomorphic glaucoma and analysis of the risk factors for developing phacomorphic glaucoma

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ABSTRACT

Background: Phacomorphic glaucoma is highly prevalent in developing countries. In India, the prevalence of phacomorphic glaucoma is 3.91%. The definitive treatment of phacomorphic glaucoma is surgery. The purpose of our study was to compare the surgical technique and outcomes of phacoemulsification and manual small incision cataract surgery (MSICS), in management of phacomorphic glaucoma and analysis of the risk factors for developing phacomorphic glaucoma.
Methods: This was a hospital based retrospective study done at a tertiary eye care center, over a period of nineteen months. A rigorous protocol to diagnose phacomorphic glaucoma was followed. All patients were given IV mannitol 20%, before surgery. The study patients were divided in to phaco group and MSICS group. The data analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.
Results: Out of 99 phacomorphic glaucoma cases, 37 underwent phacoemulsification and 62 underwent MSICS. The total number of female patients was 66 (66.67%) and that of male was 33 (33.33%) with female to male ratio of 2:1. The mean age of presentation was 63.64±8.27 years. The overall mean IOP was 42.9±9.68 mmHg in both the groups. The mean axial length was 22.47±1.03 mm in study patients and 22.82±0.8 mm in control group, (p=0.0082). The mean AC depth was 2.54±0.53 mm for phacomorphic eyes and 2.69±0.5 mm for control groups, (p=0.04).
Conclusions: MSICS is effective, safe and inexpensive in controlling IOP and achieving good visual acuity with minimal complications in the management of phacomorphic glaucoma as compared to phacoemulsification.

Keywords: Phacomorphic glaucoma, Phacoemulsification, Manual Small Incision Cataract Surgery (MSICS), Axial lengths, Anterior chamber depth

INTRODUCTION

Cataract and glaucoma are leading causes of visual impairment in Asia. As both are diseases of advancing age, they can co-exist and under certain circumstances, one disease may even lead to the other. The uptake of eye care services by the rural community has been optimal in countries like India where lens induced glaucomas are common cause of ocular morbidity.[1] Lens induced glaucoma (LIG) compromise a number of different glaucomatous processes occurring in the elderly sharing a common role of the crystalline lens in the mechanism of increase in IOP.[2]

LIG in general may be secondary angle closure (phacomorphic) or secondary open angle (phacolytic).[3] Phacomorphic glaucoma is usually caused by lens swelling in the eye due to intumescent cataract.

Phacomorphic glaucoma is highly prevalent in developing countries as has been documented earlier.[4-6] In India, a study has shown a prevalence of 3.91% phacomorphic glaucoma cases per operated cases for cataract surgery.[7] When the lens swells, angle-closure glaucoma with pupillary block occurs in the acute phase, in the late phase, it can occur without pupillary block as a result of forward movement of the peripheral iris.[8]

Management of phacomorphic glaucoma cases includes initial lowering of IOP followed by definitive treatment of removal of lens by cataract surgeries. The initial lowering of IOP is commonly done with medical treatment with combinations of topical anti-glaucoma medications, oral acetazolamide, intravenous mannitol but in 37.5% cases medical treatment has failed to show signs of improvement.[5] Mode of treatment is small incision cataract surgery with PCIOL implantation, or extracapsular cataract extraction with posterior chamber IOL implantation (ECCE with PC IOL) with or without iridectomy.[9,10] However, postoperative recovery in these conditions remains guarded. The potential intraoperative complications like expulsive hemorrhage, weakened zonules tear and unpredictable visual outcome makes management of such cases a challenging procedure.[11,12] The purpose of our study was to compare the surgical technique and outcomes of phacoemulsification and manual small incision cataract surgery (MSICS), in management of phacomorphic glaucoma and analysis of the risk factors for developing phacomorphic glaucoma.

METHODS

This was a hospital based retrospective study done at a tertiary eye care center in eastern Uttar Pradesh. The study was approved by institutional review board of the parent institution and adhered to the tenets of the Declaration of Helsinki. Informed consent was obtained from all patients before undertaking treatment options.

Case records of all the patients diagnosed with phacomorphic glaucoma between 1st February 2019 to 31st August 2020, were analyzed retrospectively and during this period total number of cataract surgeries done were also recorded.

A rigorous protocol to diagnose phacomorphic glaucoma was followed. Subjective complaints of acute pain, redness and photophobia were first noted. A thorough slit lamp examination was carried out in the glaucoma department and signs of circum corneal congestion (CCC), corneal edema, shallow anterior chamber according to Van-Herick's method was graded and IOP had to be above 21 mmHg measured on applanation tonometer to label it as phacomorphic glaucoma.

Goniscopy was done in the fellow eye to rule out angle closure glaucoma. Those patients with narrow angle and raised IOP in the fellow eye were not included in this study. USG B-scan was done in all cases to rule out any posterior segment pathology.

All patients diagnosed as having phacomorphic glaucoma were treated with topical anti-glaucoma medications, steroid eye drops, oral acetazolamide and oral glycerol. All patients were given IV mannitol 20% (1-2 g/kg body weight) before surgery. Ocular biometry was done by IOL master 700 and immersion A-scan.

Patients were given facial block followed by peribulbar block. MSICS- After superior fornix-based conjunctival flap, a partial thickness 6.0-6.5 mm sclera incision was made 2 mm behind the limbus and a scleral tunnel was extended 1 mm into clear cornea. An additional paracentesis was made at the 10 o'clock position. The anterior chamber was filled with an air bubble and 0.1 ml of trypan blue was injected under the air bubble. After several seconds, viscoelastic was used to displace the air bubble. The anterior chamber was entered with a 3.2 mm keratome. Anterior chamber was deepened with viscoelastic and capsulorrhexis (CCC) was done with double capsulorrhexis method. A sinskey hook was used to hook out one pole of the nucleus outside the capsular bag and the rest of the nucleus was rotated out anticlockwise or clockwise into the anterior chamber. The nucleus was extracted out of the eye using an irrigating vectis. After aspiration of the remaining cortex, a 6-mm optic polymethyl methacrylate posterior chamber intraocular lens was implanted into the capsular bag. The viscoelastic material was aspirated and both the wound and paracentesis were hydrated. The conjunctival flap was opposed using a forcep fitted to bipolar diathermy. Phacoemulsification was done using the AMO compact machine. The same double rhexis technique was used to perform the CCC. A 2.8 mm main entry was used for phaco. After initially aspirating the liquid cortex the nucleus was emulsified by direct chop. Care was taken during emulsification of the last piece. A foldable IOL was implanted in the bag and the wounds were hydrated.

The study patients were divided in to phaco group and MSICS group. Axial lengths and AC depths of all patients (phaco+MSICS), were compared with age and sex matched patients with mature cataract in at least one eye without having glaucoma (control group).

The data analysis was done using statistical package for social sciences (SPSS) version 21.0. A p value of<0.05 was considered statistically significant.

RESULTS

Out of 1575 operated cases during the period of one year and seven months for cataract cases, 99 were phacomorphic glaucoma cases (6.28% per operated cases for cataract surgeries). Thirty-seven patients underwent phacoemulsification and 62 patients underwent MSICS. In this study the total number of female patients was 66 (66.67%) and that of male was 33 (33.33%) with female

to male ratio of 2:1. The mean age of presentation was 63.64±8.27 years. In phaco-group the mean age of presentation was 63.97±8.94 and in MSICS-group was 63.44±7.92. Maximum number of patients (52/52.53%) presented within 10 days of onset of symptoms. The composite detail of total number of patients, age and sex, duration of symptom have been summarized in Table 1.

Table 1: General characteristics of study patients.

Pre-operative characteristics	Phaco (n=37) N (%)	MSICS (n=62) N (%)	Total (%)	P value	Test performed
Age (years)					
41-50	2 (5.41)	2 (3.23)	4 (4.04)	0.98	Fisher Exact test
51-60	13 (35.14)	24(38.71)	37 (37.37)		
61-70	15 (40.54)	25(40.32)	40 (40.40)		
71-80	6 (16.22)	10(16.13)	16 (16.16)		
81-90	1 (2.70)	1 (1.61)	2 (2.02)		
Mean±SD	63.97±8.94	63.44±7.92	63.64±8.27	0.756	t test;0.311
Median(IQR)	63(58-70)	63(58-70)	63(58-70)		
Range	43-88	45-90	43-90		
Gender					
Female	24 (64.86)	42(67.74)	66(66.67)	0.769	Chi square test,0.086
Male	13 (35.14)	20(32.26)	33(33.33)		
Duration of symptoms (days)					
0-10 days	21 (56.76)	31 (50)	52(52.53)	0.879	Fisher Exact test
11-20 days	12 (32.43)	21 (33.87)	33(33.33)		
21-30 days	3 (8.11)	6 (9.68)	9 (9.09)		
>30 days	1 (2.70)	4 (6.45)	5 (5.05)		
Mean±SD	11.43±9.34	12.76±9.76	12.26±9.58	0.508	t test;0.664
Median(IQR)	8(6-14)	11(6-16)	10(6-15)		
Range	2-50	2-61	2-61		

Table 2: Comparison of preoperative ocular clinical profile between phaco and MSICS groups.

Preoperative ocular clinical profile	Phaco (n=37)	MSICS (n=62)	Total	P value	Test performed
Preoperative BCVA					
Accurate	36 (97.30%)	60 (96.77%)	96 (96.97%)	1	Fisher Exact test
Inaccurate	1 (2.70%)	2 (3.23%)	3 (3.03%)		
Preoperative IOP (mmHg)					
25-40	16 (43.24%)	30 (48.39%)	46 (46.46%)	0.847	Chi square test,0.332
41-55	15 (40.54%)	24 (38.71%)	39 (39.39%)		
56-70	6 (16.22%)	8 (12.90%)	14 (14.14%)		
Mean±SD	43.27±8.74	42.68±10.26	42.9±9.68	0.769	t test;0.293
Median(IQR)	43(37-48)	42(34.25-50.75)	42(35-50)		
Range	28-61	28-67	28-67		
Axial length(mm)					
Mean±SD	22.66±0.91	22.35±1.08	22.47±1.03	0.142	t test;1. 478
Median (IQR)	22.68 (21.95-23.38)	22.35 (21.542-23.16)	22.42 (21.59-23.27)		
Range	21.22-24.84	19.59-25.57	19.59-25.57		
AC depth(mm)					
Mean±SD	2.62±0.55	2.49±0.52	2.54±0.53	0.251	t test; 1.153
Median(IQR)	2.51 (2.25-3.01)	2.45 (2.12-2.802)	2.5 (2.135-2.94)		
Range	1.67-3.98	1.2-3.88	1.2-3.98		

Preoperatively, 96 (96.97%), patients had accurate projection of rays, except 1 (2.70%) patient in phaco group and 2 (3.23%) patients in MSICS group, who had inaccurate projection of rays, Table 2. Preoperative mean IOP was 43.27±8.74 mmHg in phaco group and 42.68±10.26 mmHg in MSICS group. The overall mean

IOP was 42.9±9.68 mmHg in both the groups, Table 2. The mean axial length was 22.66±0.91 mm and 22.35±1.08 mm in phaco and MSICS groups respectively. The mean axial length of all study patients was 22.47±1.03 mm, Table 2. The mean AC depth of phaco group was 2.62±0.55 mm, MSICS group was 2.49±0.52 mm and overall AC depth of all study patients was 2.54±0.53 mm, Table 2.

There was no statistical significant difference among variables of phaco and MSICS groups as shown in Table-1 and Table 2. The mean axial length was 22.47±1.03 mm in phacomorphic glaucoma patients and 22.82±0.8 mm in control group (who were age and sex matched and had mature cataract in at least one eye without glaucoma). Total 99 eyes of control group were taken for comparison. The difference between axial lengths was highly significant (P=0.0082). The mean AC depth was 2.54±0.53 mm for phacomorphic eyes and 2.69±0.5 mm for control groups, this difference was also significant (P=0.04), Table 3.

Table 3: Axial length and AC depth comparison in phacomorphic glaucoma and control group.

Variables	Phacomorphic Glaucoma patients	Control group	P value
Axial length (mm) (mean± SD)	22.47±1.03	22.82±0.8	0.0082
AC depth (mm) (mean± SD)	2.54±0.53	2.69±0.5	0.04

AC: anterior chamber

Since more than 95% of patients presented for first time, measurement of lens thickness was not considered significant as it cannot rule out the possibility of thicker lens prior to phacomorphic attack.[13]

Table 4: Comparison between postoperative IOP and BCDVA undergoing Phacoemulsification and MSICS

Variable	Phacoemulsification (n=37)	MSICS (n=62)	P value
IOP (mmHg) at 2 month follow-up			
Mean±SD	16.16±2.81	16.92±4.18	0.3292
Median (IQR)	16 (14-18)	17 (14-18)	
Range	10-22	8-29	
BCDVA (log MAR) at 2 months follow-up			
Mean± SD	0.369±0.291	0.658±0.569	0.0050

IOP: intraocular pressure, BCDVA: best corrected distance visual acuity, MAR: minimum angle of resolution

The mean IOP at two months' follow-up was 16.16±2.81mm Hg in phaco group and 16.92±4.18mmHg in MSICS group. There was no statistically significant difference between IOP in phaco and MSICS groups (P=0.3292), at 2-month follow-up, (Table 4). But there was a statistically significant difference between IOP at presentation and at two-month follow-up (P<0.0001, paired t-test), in both groups.

The log MAR BCDVA, at 2 moth's follow-up was 0.369±0.291 and 0.658±0.569 in phaco and MSICS groups respectively. The BCDVA was better in phaco group than MSICS group (P=0.005), (Table 4).

Table 5: Comparison of post-operative visual acuity and duration of symptoms between Phaco and MSICS.

Postoperative BCVA 60th days PO	Preoperative IOP (mmHg) N (%)						Duration of symptoms (days) N (%)							
	25-40		41-55		56-70		0 - 10		11-20		21 - 30		>30	
	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS
6/6-6/12	14 (87.50)	15 (50)	10 (66.67)	13 (54.17)	3 (50)	0 (0)	20 (95.24)	17 (54.84)	7 (58.33)	9 (42.86)	0 (0)	1 (16.67)	0 (0)	1 (25)
6/18-6/36	2 (12.50)	9 (30)	3 (20)	8 (33.33)	1 (16.67)	2 (25)	0 (0)	8 (25.81)	4 (33.33)	8 (38.10)	1 (33.33)	2 (33.33)	1 (100)	1 (25)
6/60-3/60	0 (0)	4 (13.33)	2 (13.33)	2 (8.33)	2 (33.33)	3 (37.50)	1 (4.76)	3 (9.68)	1 (8.33)	3 (14.29)	2 (66.67)	2 (33.33)	0 (0)	1 (25)
FC/HM/LP	0 (0)	2 (6.67)	0 (0)	1 (4.17)	0 (0)	3 (37.50)	0 (0)	3 (9.68)	0 (0)	1 (4.76)	0 (0)	1 (16.67)	0 (0)	1 (25)
P value	0.081		0.761		0.146		0.006		0.861		1		1	
Test performed	Fisher Exact test		Fisher Exact test		Fisher Exact test		Fisher Exact test		Fisher Exact test		Fisher Exact test		Fisher Exact test	

Table 6: Intraoperative complications and difficulties along with postoperative complications.

Variables	Phaco (%)	MSICS (%)
Intraoperative complication		
PCR	1 (2.7)	1 (1.61)
Iridodialysis	0 (0)	1 (1.61)
Zonular dialysis	1 (2.7)	1 (1.61)
Aphakia	0 (0)	0 (0)
Intraoperative difficulties		
Wound insufficiency	1 (2.7)	3 (4.83)
Incomplete cortical clean up	1 (2.7)	2 (3.22)
Capsulorhexis extension	1 (2.7)	3 (4.83)
Pupillary constriction	7 (18.91)	4 (6.45)
Iris prolapse	3 (8.1)	4 (6.45)
Postoperative complications		
Striate keratopathy	5 (13.51)	3 (4.83)
Cystoid macular edema	2 (5.4)	1 (1.61)
Decentralization of lens	0 (0)	1 (1.61)

PCR: posterior capsular rent, Phaco: phacoemulsification, MSISC: manual small incision cataract surgery

The postoperative BCDVA at 2 months was 6/6-6/12 in 27 (72.97%) eyes out of 37 eyes in phaco group and 28 (45.16%) eyes out of 62 eyes MSICS group, 6/18-6/36 in 6 (16.21%) eyes in phaco group and 19 (30.64%) in MSICS group, 6/60-3/60 in 4 (10.81%) eyes in phaco group and 9 (14.51%) in MSICS group and finger counting (1/60)/hand movement or projection of light in 6 (9.67%) eyes in MSICS group and none in phaco group. Comparison between the postoperative BCVA, duration of symptom and preoperative IOP has been summarized in, Table 5.

Intraoperative difficulties encountered during surgery were wound insufficiency, 1 (2.70%) case in phaco group and 3 (4.83%) cases in MSICS group, incomplete cortical clean up, 1 (2.70%) case in phaco and 2 (3.22%) cases in MSICS group, capsulorrhexis extension, 1 (2.70%) case in phaco and 3 (4.83%) cases in MSICS group, pupillary constriction, 7 (18.91%) cases in phaco and 4 (6.45%)cases in MSICS group and iris prolapse 3 (8.10%) cases in phaco and 4 (6.45%) cases in MSICS group.

Intraoperative complications were, posterior capsular rent in 1 (2.70%) case of phaco and 1 (1.61%)case in MSICS group, iridodialysis in 1 (1.61%) case of MSICS group, zonular dialysis in 1 (2.70%) case of phaco and 1 (1.61%) case of MSICS group. The postoperative complications include striate keratopathy 5 (13.51%) cases in phaco and 3 (4.83%) cases in MSICS group, cystoids macular edema 2 (5.40%) cases in phaco and 1 (1.61%) case in MSICS group and decentralization of lens in 1 (1.61%) case of MSICS group only. Intraoperative difficulties and complications along with postoperative complications have been summarized in Table 6.

DISCUSSION

The aim of our study was to compare the surgical technique and outcomes of phacoemulsification and MSICS in management of phacomorphic glaucoma and analysis of the risk factors for developing phacomorphic glaucoma at a tertiary eye care center in eastern Uttar Pradesh and we found that incidence of phacomorphic glaucoma was 6.28% per operated cases for cataract surgeries, in our study. This incidence was higher than the previous study by Jain et al.[14]

In this study the mean age of phaco group was 63.97±8.94 years and MSICS group was 63.44±7.92 years, this difference was not statistically significant. Out of total 99 patients, 66 (66.67%) were females and 33 (33.33%) were males. Lee et al observed the incidence of phacomorphic glaucoma is more in above 60 years' age group and female gender, as in correlation with the present study.[15]

The mean IOP of all the study, (99) patients was 42.9±9.68 mmHg. Lee et al observed that the mean IOP among phacomorphic glaucoma was 49.5±11.8 mmHg. We found that IOP at 2 months follow-up, was reduced comparably with both cataract removal surgical techniques (phacoemulsification and MSICS).[15] Several previous studies have shown significant IOP reduction after phacoemulsification. The largest series by Yang et al 16 evaluated 999 normotensive Korean eyes undergoing uncomplicated phacoemulsification and reported a mean reduction in IOP of 1.6 mmHg at 3 months of follow-up.

In our study the overall log MAR BCDVA was better in phaco group than in MSICS group, ($p<0.005$). The final visual acuity was better in those groups which had shorter

duration between the onset of symptoms and surgery. After two months' postoperative follow-up, 54.05% in phaco group and 27.41% in MSICS group achieved good visual acuity in presentation<10 days of onset, 18.91% in phaco group and 17.74% in MSICS group, of those presented after 10 days could achieve BCVA 6/12 or better. Of the total 6 (6.06%) patients had poor visual recovery of<3/60 with glaucomatous optic changes have been found in three eyes, cystoid changes in macula in one eye, pre-existing diabetic retinopathy in two eyes.

In our study overall intraoperative difficulties faced by surgeon were 35.13% and 23.88% in phacoemulsification and MSICS respectively. Intraoperative complications were 5.4% and 4.83% in phacoemulsification and MSICS respectively. The postoperative complications were 18.91% and 8.0%, in phacoemulsification and MSICS, respectively. This shows that MSICS was more comfortable with less intraoperative and postoperative complications than phacoemulsification. Venkatesh et al and Ramakrishan et al have shown the efficacy of MSICS in management of phacomorphic glaucoma cases in terms of visual outcome and safety.[17,18]

We found that eyes with phacomorphic glaucoma had statistically shorter axial lengths compared with their age and sex matched control eyes with mature cataract (22.47±1.03 mm versus 22.82±0.8 mm, P=0.0082). There was also a statistically significant difference between AC depth of phacomorphic glaucoma and control eyes (2.54±0.53 mm versus 2.69±0.5 mm P=0.04). Many studies have reported the relative risk of increase incidence of glaucoma cases due to smaller axial length and anterior chamber depth.[19]

Axial length less than≤23.7 mm was a risk factor for developing phacomorphic glaucoma. 20 Eyes with axial lengths shorter than the population mean were 4.3 times as likely to develop phacomorphic glaucoma compared with eyes with longer than average axial length.[20] Up to our best knowledge, there has been no separate study regarding comparison of phacoemulsification and MSICS for the management of phaomorphic glaucoma and assessment of risk factors for the development of phacomorphic glaucoma, in eastern Uttar Pradesh.

Limitations

The limitations of this study was retrospective nature and small sample size.

CONCLUSION

In conclusion, manual small incision cataract surgery is effective, safe and inexpensive in controlling IOP and achieving good visual acuity with minimal complications in the management of phacomorphic glaucoma as compared to phacoemulsification.

The risk factors of developing phacomorphic glaucoma are usually elderly age, short axial length or shallow anterior chamber. Increased intraocular pressure is the one responsible for symptoms. An easy predictor for diagnosing phacomorphic glaucoma is axial length measurement. It is essential to educate the patients regarding complications of cataractous lens to avoid the problems due to phacomorphic glaucoma.

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