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A Clinical Comparative Study of Small Incision Cataract Surgery with Phacoemulsification Cataract Surgery in a Tertiary Hospital Setup

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Abstract
Background: *Cataract causes about 50% of world blindness. There is little likelihood of effective prevention becoming available in the next few years and so only treatment remains surgical. Phacoemulsification is now the standard and almost the only procedure in developed world. For various reasons, mainly socio-economical, most experts do not see phacoemulsification as the answer to the word cataract blindness. Hence the need to conduct a comparative clinical study to evaluate parameters like efficacy and visual prognosis in a cost effective procedure like SICS.*
Objectives: *This study was undertaken to evaluate SICS as a substitute to phacoemulsification by comparing clinical parameters namely astigmatism, visual acuity and post-operative complications.*
Methods: *A cross sectional study which included 30 cases of superior incision SICS, 30 cases of temporal incision SICS and 30 cases of phacoemulsification. A pre structured proforma was used to collect relevant data. Cases were selected and assigned to each group randomly. Patients were evaluated with detailed history and clinical examination which included slit lamp examination, refraction testing, and indirect ophthalmoscopy and biometry. Post operatively patients were evaluated for visual acuity, astigmatism and complications at the end of 4 weeks.*
Results: *In small incision cataract surgery - wound with temporal incision about 93.3% had stabilized astigmatism by the end of 4th week. The net induced astigmatism by temporal incision is 0.80D. Net surgery induced astigmatism for non-phaco small incision surgery was 1.069D. 49 out of 60 eyes (81.28%) had BCVA of 6/6 - 6/9. 51 out of 60 cases (85%) had stable refraction at the end of 4 weeks. The duration of steroids used post operatively was for 4-6 wks. In phacoemulsification - Net induced astigmatism for temporal frown incision was O.758D. 96.5% of eyes with frown incision had stable refraction at 4 weeks. 27 out of 30 eyes (90%) had BCVA of 6/6 - 6/9. Post-operatively steroid drops are used for 2 weeks following which NSAIDS are started.*
Conclusions: *Non phaco small incision cataract surgery can be excellent substitute to phacoemulsification cataract surgery.*
Key words*: Phacoemulsification; small incision cataract surgery; net astigmatism; surgically induced astigmatism; best corrected visual acuity.*

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I. Introduction:

Over the years from Susruthas couching to Charles D Kelmans phacoemulsification, cataract surgery has witnessed a phenomenal progress. The successful cataract surgery is determined by the best and earliest possible visual rehabilitation. But the occurrence of post-operative astigmatism is a hurdle to achieve this goal. Introduction of phacoemulsification by Kelman and no stitch surgery by Mc Farland are the major advances in reduction of post-operative astigmatism and quick visual rehabilitation. Phacoemulsification has captured the centre stage in the surgical management of cataract and has been accepted as the gold standard in the cataract surgery.[1] Charles D Kelman the pioneer in phaco surgery has written in one of his books, "Those of us who perform the technique become enamored of the procedure, elated by the white, quiet post-operative eyes, proud of the work as an artist is proud of his and empathetic with the patient who back at work the next day proclaims that he had a cataract removed the day before and has no physical limitations". It seems we are now very close to ideal cataract surgery- our ultimate goal. With better resolution of operating microscope, finer suture materials and revised surgical techniques the elusive goal of cataract surgeons is towards the ideal astigmatism

neutral cataract surgery. Cataract forms the second most prevalent treatable cause of blindness in the world today. Cataract extraction is the most frequently performed operation in patient over 60 years of Age.[2]

Cataract extraction is a simple but extremely delicate procedure. The surgeon and patients have become increasingly aware of the final optic result of any surgical intervention with the numerous significant advances in surgical methodology that have developed over the past two decades.[2] For these reasons phacoemulsification is considered as the gold standard for cataract surgery in developed world.[3] But in developing country like India for various reasons, mainly socio-economic most experts do not see phacoemulsification as the answer to the word cataract blindness. Hence we conducted a comparative clinical study to evaluate parameters like efficacy and visual prognosis in a cost effective procedure like SICS.

II. Methodology:

This documentation has been arrived at the end of the study of 90 Cataract extractions, divided prospectively into 3 groups, Group A- SICS with superior scleral incision.

Group B- SICS with temporal incision and Group C- Phacoemulsification with clear corneal incision. Similarity in the case studied was maintained as far as possible. This Strategy included selection of age factor & uncomplicated cases & all patients were operated by single surgeon. The cases with diabetic retinopathy, uncontrolled glaucoma and traumatic cataract were excluded. All cases were admitted one day prior to surgery.

Preoperative evaluation includes ,Visual acuity with pin hole, Intraocular pressure in both eyes, Patency of lacrimal system, Active or indolent foci of sepsis in ear, nose, throat and lacrimal region ruled out, Thorough fundus examination of both eyes under full Pupillary dilatation, Examination of urine sample - for albumin and sugar, Fasting blood sugar, Blood pressure, IOL power calculated by biometry (A- Scan), Keratometry readings were noted with Bausch & Lomb keratometer in the greatest & least meridian of the cornea.

Patients were randomly allotted to one of the 3 series : Group A (superior incision), Group B (temporal incision) and Group C (temporal clear corneal incision).

Surgical procedure undertaken-
Non phaco SICS

Out of 60 patients, 30 were operated by SICS with PCIOL by superior incision under LA. Remaining 30 cases were operated by SICS with PCIOL by temporal incision under local anesthesia. 5ml of anesthetic solution, i.e., mixture of 2% lignocaine with 1: 1000 adrenaline with 50 units of hyalase was given as peribulbar injection. Eyelids and surrounding areas were thoroughly cleaned with diluted betadine. Exposure of the operative field was achieved by application of eye speculum. The conjunctival irrigation done with diluted betadine and balanced salt solution. A superior rectus bridle suture was put for fixation and the eyeball was rotated downwards. A fornix based conjunctival flap was made just sufficient to accommodate the incision. Hemostasis was then achieved with bipolar wet field cautery to blanch the exposed episcleral and scleral vessels. Subsequently the external scleral incision was made. 51 For Group A, frown shaped 6 mm long external scleral incision was made 2 mm posterior to the anterior limbal border at superior limbus with a sharp guarded knife to create ½ depth scleral groove in astigmatic funnel. For Group B, frown shaped 6 mm long external scleral incision at temporal limbus 2 mm posterior to the anterior limbal border with sharp knife to create ½ depth scleral groove. Then the bevel of rounded crescent blade engaged into the scleral groove and its lamellae split along the entire length by gentle wiggled side to side movements with forward pressure. The tunnel was extended upto 1 mm into the clear cornea, just anterior to the vascular arcade careful attention was paid to assure that dissection remains at the desired depth along its entire length. While entering into the cornea, tip of the blade was kept up to follow its curvature. Then 2.8mm keratome was passed through the tunnel and at the anterior border of the tunnel in the clear cornea, the tip was angled down to create dimpling in the cornea. And anterior chamber was entered. Thus the scleral tunnel incision had 3 components: external frown /Chevron/Straight scleral incision, Sclerocorneal tunnel and internal corneal incision into anterior chamber.

Capsulotomy

After entering the anterior chamber with keratome, viscoelastic (2% hydroxyl propyl methyl cellulose) was injected and Continuous Curvilinear Capsulorrhexis was made in all cases.

A side port incision was created using a side port knife about 120 degree away from the main incision. Tunnel incision was enlarged with blunt tip extension knife cutting on the inward stroke, to the full extent of external incision. Hydrodissection was done. Nucleus was brought into the anterior chamber and viscoelastic was injected both above and below the nucleus. Irrigating vectis was passed under the nucleus and the nucleus was delivered out by hydro extraction. The residual cortical material was removed using a two way Simcoe cannula. Single piece PMMA Intraocular lens of appropriate power, with optic diameter of 6mm was then inserted into the capsular bag. The anterior chamber was inflated with fluid from side port. The inferior limbus

and the dome of the cornea was pressed to check the integrity of the wound. Subconjunctival injection of 0.5 ml of Gentamycin and 0.5 ml of Dexamethasone was instilled in the subconjunctival sac. Pad and bandage were applied. Post-operatively analgesics, sedatives and antibiotics were prescribed. Dressing was changed and the eye shade was given the next day. Topical antibiotic steroid combination was applied. Wound approximation, depth of the anterior chamber, clarity of anterior chamber and status of the fundus were examined. Any complications like striate keratitis were treated. Post-operative vision with pinhole was tested. The patients are instructed to continue antibiotic steroid drops 2nd hourly and advised to come for the first follow up after 1 week, 2nd week and then 4th week then for refractive correction after six weeks.

Surgical procedure undertaken- phaco

30 cases underwent phacoemulsification with foldable IOL under LA. Superior clear corneal incision was taken of size 3.5mm in size following fornix based conjunctival flap. Corneal tunnel is made using 2.6 tunnel crescent blade. After entry into AC with 3.2 mm Keratome phaco probe was introduced into AC and was guided into lens substance through a 6mm rhexis. For soft cataracts phaco aspiration was done and in others nucleus was emulsified using Divide and Conquer technique. The Phaco parameters were as follows: Phaco Power Vacuum (mm of Hg) Flow rate Trenching 60 100 10- 20.Quadrant emulsification 40 350-400 28 – 36.54 Cortical cleanup was done followed by in the bag placement of foldable Phaco lens. AC was formed and wound allowed self-sealing. Surgery was completed with sub-conjunctival injection of Dexamethasone 4mg and Gentamycin 20mg. Patients received topical steroid antibiotic drops and antibiotic eye drops. Topical steroid was tapered by 45 days and antibiotics was stopped at the end of 1 week. Patients were subjected to slit lamp examination on 1stpostoperative day. The V/A was recorded and so also the K reading. Thereafter they were followed up at the end of 1 week, 2 weeks, 4 weeks, and 6 weeks, During each visit BCVA, refraction, K - reading, and Slit lamp examination was done. The findings were tabulated on a specially prepared performa and various parameters were studied.

Methods of statistical analysis :

The following are the methods of statistical analysis which were applied to carry out data analysis.

T test: To test the equality of means for the 2 group ANOVA of variance was carried out at 5% level of significance using F statistics. 55

Chi square test: It is used to test for proportion in the 2 groups with respect to a categorical variable such as age, total delivery time, rate of cervical dilatation, apgar score, duration of second stage and third stage, labour complications. The chi square test is carried out at 5% level of significance. The data was analyzed using SPSS package.

P value: If the p value is less than 0.05 then we conclude that the means are not equal and the difference is statistically significant.

III. Results:

90 patients were included in this study. 47 patients were males and 43 of them were females. Patient's age ranged from 40 to 85 years. Mean age of patients was 62.5yrs. Clinically hardness of lens nucleus was graded based on slit lamp evaluation of colour of nucleus.

Table – 1: Number of eyes in each group based on nuclear grade of cataract.

Grade Of Nucleus	Colour Of Nucleus	Number Of Eyes	Percentage	Non phaco	Phaco
I	White or greenish yellow	5	8.2	2	3
II	yellow	47	52.2	34	13
III	amber	31	34.4	19	12
IV	brown	7	7.7	5	2

80 eyes underwent CCC, remaining 8 underwent can opener capsulotomy due to run over of the rhexis margin and thick rigid capsule.

Non phaco surgery: 60 patients underwent non phaco surgery. 34 of them were males and 26 females. Age of the patients ranged from 40 to 80 yrs with mean age 60 yrs. Grade II cataract was commonest and was seen in 34 eyes (56.6%). Brown cataract (Grade IV) was seen in 5 eyes (8.33%). superior scleral incision had a subset study with different shapes of incisions.

Table 2. Number of eyes in superior incision divided according to the shape of incision

Type	Number of eyes	Percentage
Straight	7	23.3
Frown	16	53.3
Chevron	7	23.3

All temporal incision cataract surgeries were frown shaped. The commonest intra operative complication was hyphaema seen in 5 cases (8.3%), of which 4 (6.6%) cases are from temporal incision and 1 (1.6%) from superior incision. The reason for hyphaema being wound bleed and all 5 patients were hypertensive patients on medications and also on blood thinners. 3 patients had posterior capsule rupture of which 2 from superior incision and 1 from temporal incision. Two eyes with PC rent occurred in grade III and grade 1V nucleus while dialing the nucleus into AC while in one eye with grade II nucleus it ruptured during the stage of irrigation and aspiration. All 3 patients had IOL placement in the sulcus and had not much vitreous disturbance. The common complication in the immediate post-operative period was corneal oedema with 5 cases (8.3%), striate keratopathy was seen in 3 cases more common with superior than temporal incision. No major complication noted in late post operative period.

Table 3: Considering the surgery induced astigmatism in non phaco patients

Astigmatism In Diopters	**Number Of Eyes**	**Superior incision**			**Temporal frown**
		Straight	**Frown**	**Chevron**	
< 0.25	12	0	2	2	8
0.5	14	0	3	3	8
1.0	19	2	7	1	9
1.5	11	3	3	0	5
2.0	2	0	1	1	0
>2.0	2	2	0	0	0

45 eyes had less than or equal to 1 D of induced astigmatism. 46 eyes had frown incisions out of which 37 eyes had astigmatism of <1D indicating that surgery induced astigmatism was less with frown incision.

Among superior and temporal frown incision temporal frown had 25 eyes out of 30 eyes astigmatism of <1D and superior frown had 12 eyes out of 16 eyes astigmatism of <1D.

Chevron incision was taken in 7 eyes out of which 6 eyes had astigmatism of <1D. Surgery induced net astigmatism was found to be 1.05 D. Frown incision induced net astigmatism (superior + temporal) of 0.817D while superior frown incision induced 0.976D of astigmatism. Straight incision induced 1.5 D of astigmatism. Chevron incision induced the least astigmatism of 0.732D, while temporal frown incision was in close comparison to it with 0.80D.

Table 4: Net astigmatism in non phaco surgeries.

Incision	**Net astigmatism**
Frown (sup + temp) Superior Temporal	0.817 0.976 0.800
Chevron	0.732
Straight	1.5

Table 5: Astigmatism stabilized in 4th week in the following pattern.

Incision	Number of eyes	Percentage
Straight	3	42.8
Frown (sup + temp)	14	87.5
Chevron	6	85.7
Temporal	28	93.3

Astigmatism was stabilized earlier in frown incisions than straight incisions.

Table 6: The pattern of visual recovery at the end of 4 Weeks

BCVA	Number Of Eyes	Percentage
0.0-0.18	49	81.2
0.30 - 0.48	8	13.3
0.60-0.78	3	5.5
1.00	0	0

PHACO SURGERY

30 patients underwent phaco surgery. Of which14 were males and 16 females.

Age of patients ranged from 40- 80 years, mean age being 57 years. Grade II nucleus was most common 46.6%. All 30 cases had temporal frown incision of size 3.5mm with foldable IOL implantation. Anterior Capsular management was done by continuous curvilinear Capsulorrhexis method for all 30 cases. The most common complication was PC rupture seen in 3 eyes (10%). One eye with PC rent occurred in grade II nucleus while sculpting, while in two eyes with grade IV nucleus it ruptured during the stage of fracturing the nucleus (66.7%). The common complication in the immediate post-operative period was striate keratopathy seen in 3 eyes (10%).

Table 7: Net surgery induced astigmatism (SIA)

Group	Net astigmatism (D)	Mean	Standard deviation	SIA
A) Superior SICS				
Straight	1.50	1.050	0.63109	1.069
Frown	0.976			
Chevron	0.732			
B) Temporal SICS	0.80	0.733	0.4496	0.612
C) Phaco temporal frown	0.758	0.7750	0.4275	0.522

Table 8: Surgery induced astigmatism in phaco surgery

Astigmatism In Diopters	**Number Of Eyes**	**Percentage**
< 0.25	3	10
0.5	12	40
1.0	11	36.6
1.5	2	6.3
2.0	1	3.3
>2.0	0	0

Table 9 : The pattern of visual recovery at the end of 4 Weeks

BCVA	Number Of Eyes	Percentage
0.0-0.18	27	90
0.30 - 0.48	3	10
0.60-0.78	0	0
1.00	0	0

Table 10: Comparison of group A, group B, and group C by ANOVA

Comparison	P-Value
Group A & B	0.726
Group A & C	0.779
Group B & C	0.713

Table 11: Statistical analysis among the groups.

Groups	**Mean**	**SD**	**T value**	**P value**
Group A & B				
Group A	1.050	0.6310	2.246	0.029
Group B	0.733	0.4449		
Group B & C				
Group B	0.7333	0.4449	0.370	0.713
Group C	0.7750	0.4272		
Group A & C				
Group A	1.050	0.6310	1.976	0.049
Group C	0.7750	0.4272		

Statistically significant p value was obtained between Group A & B and between Group A & C. Where as in Group B & C p value is not significant. Hence surgeries performed by superior incision produces significant differences in astigmatism compared to temporal scleral incision and temporal phaco where as temporal scleral incision and temporal phaco do not show significance in net astigmatism.

IV. Discussion

Phacoemulsification is the preferred technique for cataract surgery in developed countries, and also to some extent in the developing countries. An alternative surgical technique, manual sutureless small incision extracapsular cataract surgery, is been around for a longtime, as the technique has been shown to yield comparable surgical outcomes as phacoemulsification.[4] Both phacoemulsification and manual small incision cataract surgery (MSICS) achieve excellent visual outcomes with low complication rates, but MSICS is less expensive and requires less technology; hence, preferred by many surgeons in the developing countries.[5] The scleral tunnel incision in cataract surgery was introduced in the early eighties in an attempt to provide better wound healing with less surgically induced astigmatism. The length of the incision varies from 5 to 8 mm; however it is still called small incision cataract surgery since the architectural design renders sutureless, self sealing property to the incision.[6] Although, Richard Kratzwas the first surgeon to change the cataract incision from limbus to the sclera to produce enhanced wound healing and less astigmatism, Girard and Hoffman were the pioneer to name this posterior incision as Scleral Tunnel Incision.[7] Singer described the 'Frown incision' which was a modified pocket incision, curved opposite to limbus. In a series of 62 eyes, he performed postoperative vector analysis calculation of mean induced keratometric astigmatism for the frown incision group versus the scleral pocket incision group. It was 0.80 D versus 1.19 D (P = 0.02) at day 1; 0.74 D versus 1.03 D (P = 0.05) at one week; 0.71 D versus 1.07 D (P = 0.005) at four weeks; 0.84 D versus 1.15 D (P = 0.007) at six months; and 0.82 D versus 1.30 D (P = 0.01) at one year. The frown incision group consistently had a lower standard deviation from the mean induced astigmatism than the scleral pocket incision group.[8] In our study at the end of 4th week frown incision had (superior + temporal) 0.81D of astigmatism against 1.5D straight incision (P = 0.029) which is in correlation with the above study.

Gokhale et al compared the induced astigmatism with various positions of scleral incision (superior, supero-temporal and temporal incision) in MSICS. The study found that induced astigmatism was lower in the temporal and superotemporal groups compared to that in the superior group.[9] In our study the net induced astigmatism for temporal incision was 0.80D and for superior incision 1.069D. Gayton in his study suggested temporal incision for cataract surgery in patients with superior glaucoma filtering blebs.[10]

Gogate et al reported that MSICS is almost as effective as phacoemulsification, but less expensive.[11] Reddy et al. compared the astigmatism induced by superior and temporal incisions in manual SICS, and compared the astigmatism induced by clear corneal incision versus scleral tunnel in phacoemulsification surgery. A total of 64 eyes of 64 patients (34 male/ 30 female) with a mean age of 62.10 years (range 45-82 years) were included in the study. They found a significant against the rule shift in astigmatism in the phacoemulsification group and the manual SICS superior incision group. The manual SICS group with temporal incision had with-the-rule shift in astigmatism. At 90 days, conventional SICS superior incisions showed 1.92 ± 0.53 D of against the rule astigmatism and temporal incisions showed 1.57 ± 0.24 D of with the rule astigmatism. Phacoemulsification with clear corneal incisions and scleral pocket showed 1.08 ± 0.36 D and 1.23 ± 0.71 D of astigmatism respectively.[12] Our study is in correlation with the study. The manual SICS group with temporal incision had with-the-rule shift in astigmatism conventional SICS superior incisions showed 1.069 ± 0.43 D of against the rule astigmatism and temporal incisions showed 0.80 ± 0.34 D of with the rule astigmatism. Phacoemulsification with clear corneal incisions and scleral pocket showed 0.758 ± 0.26 D and 1.23 ± 0.71 D of astigmatism respectively.

Ruit et al. compared the efficacy and visual results of phacoemulsification vs MSICS for the treatment of cataracts. They compared cases on parameters like operative time, surgical complications, uncorrected visual acuity (UCVA), BCVA, astigmatism, and central corneal thickness (CCT). They found that both the surgical techniques achieved excellent surgical outcomes with low complication rates. At six months, 89% of the SICS patients had UCVA of 20/60 or better and 98% had a BCVA of 20/60 or better vs 85% of patients with UCVA of 20/60 or better and 98% of patients with BCVA of 20/60 or better at six months in the phaco group (P = 0.30). Surgical time for SICS was much shorter than that for phacoemulsification (P< .0001). They concluded that SICS is a more appropriate surgical procedure for the treatment of advanced cataracts in the developing world.[13] Our study showed BCVA of 6/6-6/9 in 89.2% at the end of 4th week for SICS vs. 90% in phacoemulsification. Surgical time for SICS was shorter than phacoemulsification.

George et al compared Surgically Induced Astigmatism (SIA) following MSICS and phacoemulsification (PE) in 186 eyes with nuclear sclerosis of grade 3 or less. Mean SIA was 1.17D (0.95D) in the SICS group and 0.77D (0.65D) in the PE group (P = 0.001). PE induced less astigmatism than SICS.[14] In our study Mean SIA was 1.069D (0.95D) in the SICS group and 0.758D (0.65D) in the PE group .PE induced less astigmatism than SICS.

Gogate et al. compared the efficacy, safety, and astigmatic change after cataract surgery by phacoemulsification and MSICS. The intraoperative and postoperative complications, UCVA, BCVA, and astigmatism were recorded at 1 and 6 weeks postoperatively. They found that 68.2% patients in the phacoemulsification group and 61.25% patients in the SICS group had UCVA better than or equal to 6/18 at 1

week. At 6 weeks follow up, 81.08% patients in the phacoemulsification group and 71.1% patients in the SICS group had UCVA of better than or equal to 6/18. They concluded that both phacoemulsification and SICS are safe and effective for visual rehabilitation of cataract patients, although phacoemulsification gives better UCVA in a larger proportion of patients at 6 weeks.[15] Our study is in correlation with the above study. 84.3% patients in the phacoemulsification group and 77.3% patients in the SICS group had UCVA better than or equal to 6/18 at 1 week. At 6 weeks follow up, 90% patients in the phacoemulsification group and 89% patients in the SICS group had UCVA of better than or equal to 6/18.

Gogate et al. in another study, compared the cost of phacoemulsification with foldable lens with that of MSICS in a hospital setting. The average cost of a phacoemulsification surgery for the hospital was Indian rupees (Rs) 1978.89 ($42.10), and the average cost of a SICS surgery was Rs 720.99 ($15.34), of which Rs 500.99 ($10.65) was the fixed-facility cost common to both. They found that MSICS is far more economical than phacoemulsification.[16]

Tabin et al reviewed the published literature and concluded that MSICS may be the preferred technique for cataract surgery in the developing world. It is significantly faster, less expensive and requires less technology.[17]

V. Conclusion

Smaller the length of the incision, smaller the astigmatism induced. Frown incision is superior to other incisions as induced astigmatism is less, quicker stabilization of refraction, better self-sealing effect and wound related complications are less. Phaco surgery is superior as net surgery induced astigmatism is less, quality of visual recovery is better, shorter time is taken for visual rehabilitation. The non-phaco small incision surgery has the advantage of being cost- effective as it does not involve the use of sophisticated instrumentation. The learning curve for this procedure is less as the conventional ECCE surgeon can quickly adapt to this new surgical technique and results are comparable to phaco surgery. Hence non phaco small incision cataract surgery can be excellent option to phaco cataract surgery.

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