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Scleral tunnel based sutureless extracapsular cataract extraction: An approach to astigmatic correction in soft cataracts of NS1 grade nuclear sclerosis.

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Abstract:
Background:*A study to see if scleral tunnel based sutureless extracapsular cataract extraction with superior quadrant approach can correct pre-existing corneal astigmatism in soft cataracts of NS1 grade nuclear sclerosis in patients of younger age profile having 'with-the-rule' pattern of corneal astigmatism.* ***Design****: A prospective interventional study conducted at the ophthalmology centre of a military hospital.* ***Participants:*** *47 eyes of 41 patients who underwent scleral tunnel based sutureless extracapsular cataract extraction were taken as the study group and a second group of 44 eyes of 38 patients whounderwent clear corneal incision based phacoemulsification surgery formed the control group.****Methods****:Only soft cataracts of NS1 grade nucleus having 'with–the-rule' corneal astigmatism were included in both the study and control groups. Keratometry measurements were done pre-operatively and at 6 weeks post-operative follow-up by zeissIOLMaster.****Main outcome measure****: The total surgical induced astigmatism measured in dioptres as the sum total of the absolute amount of corneal flattening / decrease in K value in steeper vertical meridian plus the absolute amount of corneal steepening / increase in K value in the flatter horizontal meridian.****Results:****Flattening of steeper vertical meridian associated with steepening of horizontal meridian of the cornea of eyes in both groups were observed. The amount of surgical induced astigmatism were 0.81511+ 0.14663 (SD) in the study group and 0.43591 + 0.0588 (SD) in the control group respectively.* ***Conclusions and Relevance:****Sutureless scleral tunnel based extracapsular cataract extraction was found to neutralise pre-existing corneal astigmatism if it was in range of 1.0 D to 1.5 D. It was also found to change the pattern of astigmatism from 'with-the-rule' to 'against-the-rule' if it was in the range of 0.5 D to 1.0 D with little change in the absolute value of the astigmatism. This resulted in reduced requirement of corrective glasses for distant vision. Phacoemulsification on other hand was found to be an astigmatically neutral surgery.*

Key words: Corneal astigmatism, Suturelessextracapsularcataract extraction, Phacoemulsification, Keratometry

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I. Introduction

Cataracts are caused by the degeneration and opacification of lens fibres already formed, the formation of aberrant lens fibres or the deposition of other materials in their place[1].Treatment remains surgical removal with implantation of an intraocular lens. With advancementsin technology, cataract surgery is now also expected to be a refractive surgery in addition to being a lenticular surgery and patients expect post-operative freedom from spectacles along with a painless visual recovery.

There is a constant effort by ophthalmologists to come up with surgical innovations to improve the visual outcome following cataract surgery. Extraction byphacoemulsification and placement of a posterior chamber intraocular lens in the capsular bag has become the routine procedure in most parts of the world. Scleral tunnel based sutureless extracapsular cataract surgery (also known as manual small incision cataract surgery in some parts of the world) had often been considered a low technology, unproven technique compared with phacoemulsification[2].However, it remains an important tool for eliminating blindness due to cataract especially in thedeveloping countries[3] and studies have reported equivalent outcomes between these two surgical techniques [4,5]. However, astigmatismremains an important cause of low uncorrected visual acuity in post-operative patients[6]. One of the advantages of phacoemulsification reported in literature is better unaided visual acuity compared withthe extracapsular technique as the result of less surgical induced astigmatism seen in phacoemulsification[7].While this may be true for harder cataracts as their removal by manual scleral tunnel based extracapsular extractionwill require larger incisions, the clinical significance of this difference in surgical induced astigmatism between these two techniques remains debatable[8]. And cataracts with softer nuclei will

require smaller incisionswith manual scleral tunnel based extracapsular extraction and post-operative astigmatism can be reduced by choosing the right surgical approach and the pattern of incision in these cases[9].

The manual scleral tunnel based extracapsular cataract extraction has undergone innovative changes and often times considered as alternate option for phacoemulsification particularly in developing countries due to lack of resources. It is also a much faster and cost effective technique.This study was done to see if this surgical technique can reduce or neutralise a pre-existing 'with-the-rule' corneal astigmatism in soft cataracts of NS1 grade nucleus.

II. Methods

Study Design:A prospective interventional study was conducted at the ophthalmology centre of a military hospital of the Indian Armed Forces. **Study population:**47 eyes of 41 patients underwentscleral tunnel based sutureless extracapsular cataract extractionand formed the study group. A control group of 44 eyes of 38 patients who underwent clear corneal incision based phacoemulsification surgery was also taken.All eyes in both groups had soft cataractous lens of nuclear sclerosis grade 1 based on the lens opacity classification system (LOCS) III[10] after clinical examination with slit lamp bio-microscopy. All the eyes included in the study and control groups had 'with-the-rule' corneal astigmatism with the steeper corneal axis between 70 degrees and 120 degrees. Eyes with other pre-existing ocular morbidities were excluded from both the study and control groups.

Approval of ethics committee: Patients were included in the study after obtaining informed and written consent for the procedure. Written consent was also obtained from the patients about publishing the findings.The study was evaluated by the Ethics Committee and since boththe techniques of cataract removal by phacoemulsification and sutureless scleral tunnel based manual extraction are accepted in practice, a formal ethics approval was not required.

Study procedure: For all eyes operated in the study group, peribulbar anaesthesia with mixture of lignocaine 2%, bupivacaine 0.5% and hyaluronidase was given. Superior rectus bridle suture was passed with 4-0 prolene suture. Peritomy was done superiorly from 10 O'clock to 2 O'clock andany bleeding vessels visible in the scleral bed were cauterised with bipolar cautery.A side stab incision was made between 9 and 10 O'clock positions with the side port knife and entry made into the anterior chamber. This was followed by staining of the anterior lens capsule with tryptan blue dye. Continuous curvilinear capsulorrhexis (CCC) was done with the bent tip of a 26G needle. After completion of capsulorhexis, a 6.00 mm long and 300 to 400 micron deep incision was made on the sclera in the shape of a frown with the centre of the incision line being 2 mm away from the limbus , and the end points of the incision line being 4.0 mm to 4.5 mm away from the limbus. Then, through this incision line a scleral tunnel was constructed using crescent ophthalmic knife forming a trapezoid shaped tunnel wound with the inner end of the tunnel about 7 mm in length and extending 1.5 mm into the clear corneaand into the sides forming scleral pockets.Then, entry was made into anterior chamber using a keratome knife through the scleral tunnel wound. Cortical cleaving hydrodissection was done and nucleus rotated inside the bag and dialled out of the bag with the sinskey hook.Hydroxypropylmethyl cellulose 2% gel was injected between the lens and corneal endothelium and below the lens to inflate the capsular bag and lens deliverywas done by visco-expression by pressing down the posterior lip of the scleral tunnel to open it up or with a wire vectis.Anterior chamber was reformed, residual cortical matter aspirated using a simcoe two way irrigation/aspiration cannula. A rigid 6.00 mm optic polymethyl methacrylate (PMMA) posterior chamber intraocular lens was implanted in the capsular bag. Residual viscoelastic was removed, intracameral preservative free moxifloxacin hydrochloride 0.5% solution was given, the side port incision was hydrated, conjunctiva over the scleral tunnel was reposited back by using cautery.

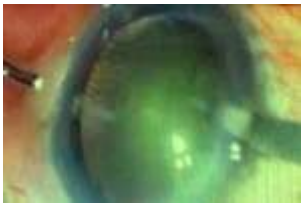

Fig 1: Side port incision between 9 and 10 O clock.
(Image produced with consent from patient)

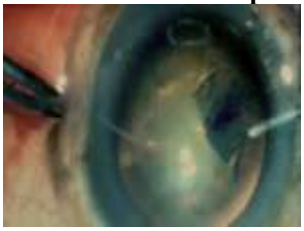

Fig 2: Continuous curvilinear capsulorhexis.
(Image produced with consent from patient)

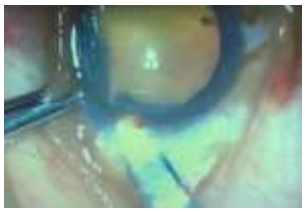

Fig 3: Construction of the scleral tunnel using crescent knife.
(Image produced with consent from patient)

Fig 4: Nucleus delivery using wire vectis.
(Image produced with consent from patient)

Fig 5:Posterior chamber IOL in bag with simcoe cannula in AC.
(Image produced with consent from patient)

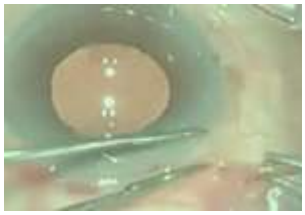

Fig 6: Reposition of conjunctiva using cautery.
(Image produced with consent from patient)

Eyes in the control group were also operated under peribulbar anaesthesia. A side stab incision was made between 9 and 10 O'clock positions by a side port knife and entry made into the anterior chamber.This was followed by staining of the anterior lens capsule with tryptan blue dye.Continuous curvilinear capsulorrhexis (CCC) was performed with the bent tip of a 26G needle. A clear corneal main incision was made at 11 O'clock position with a 2.8 mm keratome knife.Another side stab incision was made at 1 O'clock position. Cortical cleaving hydrodissection was done and nucleus rotated inside the bag. Stop and chop technique of nucleotomy was done in which trench was made in nucleus, nucleus was divided into two halves and phacoemulsified. This was followed by aspiration of remnant cortical matter with bimanual irrigation-aspiration cannulae. In cases where it was difficult to divide the nucleus, it was prolapsed out of the capsular bag into the anterior chamber and emulsified after coating the corneal endothelium with chondroitinsulphate-sodium hyaluronate gel. Alcon INFINITI vision system was used for operating these eyes. Hydrophobic acrylic foldable unifocalintraocular lens was implanted in the capsular bag, the residual viscoelastic was removed, intracameral preservative freemoxifloxacin hydrochloride 0.5% solution was given and the wounds were hydrated.

Fig 7: Side port incision between 9 and 10 O clock positions.
(Image produced with consent from patient)

Fig 8: Continuous curvilinear capsulorhexis
(Image produced with consent from patient)

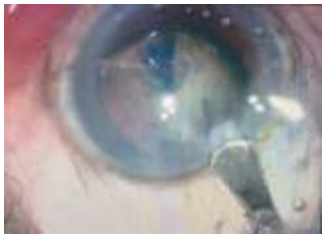

Fig 9: Construction of the clear corneal main incision
(Image produced with consent from patient)

Fig 10: Division of the nucleus
(Image produced with consent from patient)

Fig 11: Aspiration of residual cortical matter
(Image produced with consent from patient)

Fig 12: Implantation of foldable IOL
(Image produced with consent from patient)

There were no intra-operative complications in both the study and control groups and patients were put on frequent topical preservative free moxifloxacinhydrochloride 0.5% + dexamethasone phosphate 0.1% which was gradually tapered over 5 weeks. Post operative recovery was uneventful and complete ophthalmological evaluation was repeated at 6 weeks follow up including unaided visual acuity, best corrected visual acuity and keratometry readings using zeissIOLMaster.

III. Results

	Study group	Control group	Calculated t value (Independent samples t Test)
Age in years	48.23+2.60289(SD)	48.84+2.91702(SD)	-1.0553
Percentage of males	30 males out of 41 patients (73.17%)	27 males out of 38 patients (71.05%)	-
Eyes having unaided VA 6/9 or better at 6 weeks	41 out of 47 eyes (87.23 %)	37 out of 44 eyes (84.09%)	-
Mean unaided visual acuity at 6 weeks (logMAR)	0.15872+ 0.07264 (SD)	0.17318+0.06205 (SD)	-1.01171
The average time for surgery in minutes.	14.2766 + 1.65111(SD)	21.3182+ 1.72226(SD)	19.796
Mean surgical induced astigmatism in dioptres	0.81511+ 0.14663 (SD)	0.43591+ 0.05880 (SD)	15.895

*SD = standard deviation

Table 1

Statistical analysis: Independent samples t test was done to see for any statistically significant differences in the mean age, mean unaided visual acuity at 6 weeks follow up measured in logMAR scale, average time taken for surgery and mean surgical induced astigmatism between the two groups. Critical t was1.9867 for p value of 0.05.

IV. Discussion

Comparison of the calculated t and the critical t for the mean age in the two groups for a p value of 0.05 indicated that the two groups were matched for age. The mean ages of 48.23+2.60289 (SD)yrs in the study group and 48.84 +2.91702 (SD) yrs in the control group also indicated that patients in both the study and control groups had eyes with earlier onset of cataract[11].This also explains why these patients have softer cataracts of grade 1 nuclear sclerosis[12].The type of astigmatism present in both groups were of 'with-the-rule'pattern with the steeper corneal axis in the vertical meridian and the flatter axis in the horizontal meridian. This was in agreement withthe results of several studies about 'with-the-rule' astigmatismbeing more prevalent in younger age groups and astigmatism changing to 'against-the-rule'pattern with advancing age due to changes in the cornea [13,14].

There were 30 males out of 41 patients (73.17%) in the the study group and 27 males out of 38patients (71.05%) in the control group. At 6 weeks follow-up period, 41 eyes out of 47 eyes in the study group and 37 eyes out of 44 eyes in the control group had uncorrected visual acuity of 6/9 or better. These eyes had no need of corrective glasses for distant vision. The percentage of eyes not requiring corrective glasses for distant vision at 6 weeks follow up was found to be marginally more in the study group (87.23%) than in the control group (84.09%). It may seem to indicate that the refractive results in the study group were as good as those in the control group, if not better. However there was no significant difference in the mean visual acuity measured in logMAR scale at 6 weeks follow-up as shown by the calculated t value of -1.01171againstthe critical t of 1.9867 for p of 0.05. Perhaps more studies with larger samples may be required to substantiate this. The mean surgical time was also found to be less in the study group.

The amount of surgical induced astigmatism measured in dioptres as the sum total of the absolute amount of corneal flattening / decrease in K value in steeper vertical meridian plusthe absolute amount of corneal steepening / increase in K value in the flatter horizontal meridian were 0.81511 + 0.14663 (SD) in the study group and 0.43591 + 0.0588 (SD) in the control group respectively.This difference was found to be statistically significant by the independent samples t test. It shows that phacoemulsification produces less astigmatical changes and is an astigmatically neutral procedure. This is also in agreement with studies reported in literature[15,16]. However it also meant that any significant corneal astigmatism in pre-operative period will continue to remain in the post-operative period along with the requirement of corrective glasses for distant vision.

The surgical induced astigmatism in the study group was foundto neutralise any pre-existing 'with-the-rule' corneal astigmatism in the range of 1.00 to 1.50 D, thereby reducing or eliminating the requirement for corrective glasses for distant vision in the postoperative period. In cases where the pre-existing corneal astigmatism was in the range of 0.50D to 1.00 D, this surgical induced astigmatism tended to overcorrect the pre-existing astigmatism and changing the pattern from 'with-the-rule'to 'against-the-rule' with the horizontal meridian now becoming steeper than the vertical meridian while the absolute value of the astigmatism didn't differ much. These eyes also had either reduced requirement or no requirement of corrective glasses for distant vision in the post operative period.

V. Conclusions

For eyes having softcataracts of grade 1 nuclear sclerosis and 'with-the-rule' pattern of corneal astigmatism in younger age groups, the refractive results of superior quadrant approach suturelesscleral tunnel based extracapsular cataract surgery are as good as those of clear corneal based phacoemulsification surgery, if not better. Sutureless scleral tunnel based extracapsular cataract extraction was found to neutralise pre-existing corneal astigmatism if it was in range of 1.0 D to 1.5 D. It was also found to change the pattern of astigmatism from 'with-the-rule' to 'against-the-rule' if it was in the range of 0.5 D to 1.0 D with little change in the absolute value of the astigmatism. This resulted in reduced requirement or no requirement of corrective glasses for distant vision in the postoperative period for these eyes. Phacoemulsification on other hand was found to be an astigmatically neutral surgery.

A more precise correlation between the length and pattern of the scleral based incision and amount of correction of pre-existing astigmatism will require more studies. And also most patients requiring cataract surgery in ophthalmological practice are of older age group, and most of them have 'against-the-rule' pattern of astigmatism[17]and will require temporal based incisions to tackle it. Further studies will be required to see ifa sutureless scleral tunnel based extracapsular cataract extraction with a temporal approach can reduce/eliminate this 'against-the-rule' corneal astigmatism.

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Conflict of interest
The authors declare that there are no conflicts of interest.

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