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Original article ● ● ● ●

Preliminary experiences with limbal relaxing incision for treatment of astigmatism during phacoemulsification

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Abstract

Introduction: This small study relates our early experiences with the Limbal Relaxing Incision (LRI) for management of astigmatism in patients undergoing cataract surgery.

Aims: To evaluate the efficacy of LRI in the management of primary astigmatism when combined with phacoemulsification.

Subjects and methods: Limbal relaxing incisions were performed to correct primary astigmatism in 12 eyes of 12 cataract patients who underwent phacoemulsification as the primary procedure. The length and number of incisions were determined using the AMO LRI calculator software programme using Donnenfield and NAPA nomograms. Keratometric astigmatism was measured preoperatively and postoperatively on day 1 and after 3 weeks or more. Surgically-induced astigmatism (SIA) and the intended angle of error were evaluated by the vector analysis method. Preoperative and postoperative uncorrected visual acuity (UCVA) and best spectacle corrected visual acuity (BSCVA) were evaluated in each visit.

Results: The mean age of patients was 52.92 ±10.91 years. There were 75 % male and 25 % female patients. The mean keratometric preoperative astigmatism was 2.08 ±1.05 diopter. The mean 1st postoperative day keratometric astigmatism was 1.74 ±1.32 diopter and the mean final keratometric astigmatism at 3 weeks postoperatively was 1.05± 0.68 diopter. The mean SIA on the 1st postoperative day was 2.97 ±1.72 diopter at 103.25±56.57 degree with intended angle of error 6.53±9.61 degree. The mean SIA on the 3rd postoperative week was 2.26±0.87 Diopter at 107.08±49.96 degrees with intended angle of error 2.90±7.87 degrees.

Conclusion: Limbal relaxing incisions are effective method to reduce postoperative astigmatism with good predictability of intended angle.

Keywords: limbal relaxing incision (LRI), uncorrected visual acuity (UCVA), surgically induced astigmatism (SIA), angle of error, target astigmatic treatment (TAT)

Introduction

Small-incision cataract surgery using phacoemulsification has revolutionized cataract surgery. Technology permits us to perform surgery via 3 mm or less incision that results in insignificant amounts of surgically-induced astigmatism. Nevertheless, there is a significant proportion of cataract patients who have pre-existing astigmatism of 1 diopter (D) or more, and this maybe as high as 30 % in a general cataract population (Nichamin, 2006). Even small amounts of preoperative or induced astigmatism may lead to dissatisfied patients who will complain of postoperative blurring and halo formation.

This has led to the development of the concept of refractive cataract surgery where various surgical techniques have emerged that safely and effectively reduce corneal astigmatism to less than 0.5 D of cylinder. These include On-Axis Incision (OAI), Astigmatic Keratomy (AK), Toric Intraocular Lenses and Limbal Relaxing Incisions (LRI), each with its distinct advantages and disadvantages (Akura, 2000;

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Titiyal, 2002). Studies have shown that intra-limbal peripheral arcuate relaxing incision or LRI when performed in combination with phacoemulsification is a safe and effective method of controlling preoperative astigmatism of up to 3.0 D, (Nichamin, 2006).

This study presents our preliminary experiences at Lumbini Eye Institute with LRI in combination with phacoemulsification and foldable posterior chamber intraocular lens (PCIOL) implantation in cataract patients with pre-existing corneal astigmatism.

Subjects and methods
The study was conducted in Lumbini Eye Institute, Siddharthanagar, Nepal, from March to October 2008. A retrospective chart review of all phacoemulsification patients who had undergone LRI by a single surgeon (BRS) was performed. Two patients were not included in the study due to intraoperative complications. Another three patients were excluded due to inadequate follow-up. All cases underwent routine systemic and ocular examination. Patients with corneal and posterior segment pathology were excluded from the study. Furthermore, patients with complicated cataracts, glaucoma and high myopia were not considered for LRI. Following slit-lamp biomicroscopy, the patients underwent refraction to determine the best spectacle-corrected visual acuity (BSCVA) followed by keratometry using a Bausch and Lomb type Keratometer (Topcon). Applanation type A scan (Alcon) was performed to measure the axial length and SRK-II formula was used to determine the intraocular lens power. Corneal pachymetry and topography were not performed. Patients having 1.0 D or more of corneal astigmatism were selected for the LRI. Biometry data was entered in the AMO-LRI calculator (version 4.40) to determine the site, size and design of the LRI.

All surgeries were performed by a single surgeon. With the patient in a sitting position, horizontal limbal markings at 180° were made using a Bores 2 Ray meridian marker (Mastel). All patients were given posterior peribulbar blocks combined with facial blocks when necessary. Sterile draping was done in the usual fashion. With the patient in a supine position, meridians for LRI and phaco incision were marked using the Bores 2 Ray meridional marker and Gimbel Mendez fixation guide ring (Mastel). The LRI site and length were determined using the software based on the nomogram. The classic

Nichamin 600 μ preset Triamond scalpel (Mastel) was used to make paired arcuate LRIs that were placed in the clear cornea just internal and parallel to the limbus. This was followed by phacoemulsification and aspiration (AMO Sovereign) via a 3 mm single plane Clear Corneal Incision (CCI) placed at the site determined by the nomogram. Where LRI and phaco incisions overlapped, hinge type clear corneal incisions were performed with the phaco incision placed within the LRI. Foldable acrylic intraocular lenses (Fred Hollows IOL Lab) were placed inside the capsular bag in all cases. Intracameral Cefuroxime 1.0 mg was injected at the end of surgery followed by application of a topical antibiotic-steroid ointment, and a patch and shield placed overnight. Postoperative visual acuity, keratometric readings, refraction and slit-lamp examination were performed on day 1 and after 3 weeks or later of the follow-up.

Vector analysis using SIA-software (www.aios.org) was used to determine the surgically- induced astigmatism and evaluate the efficacy of astigmatic correction. The effectiveness of the LRI procedure was evaluated by comparing the preoperative and postoperative keratometric astigmatism. In addition, mean and standard deviation of postoperative keratometric astigmatism and angle of error were used to determine the efficacy of LRI at 3 weeks of follow-up. Target astigmatic treatment (TAT) was determined from AMO LRI calculator. Magnitude of error (ME) was determined by the arithmetic difference between the magnitudes of SIA and TAT. The safety of the procedure was evaluated by comparing pre- and post-operative uncorrected visual acuity (UCVA) and best corrected visual acuity (BCVA) expressed in logMAR units.

An informed consent was obtained from all the patients and ethical clearance was obtained from the Ethics Sub-committee of the institute's Research Committee.

Results
A total of 12 eyes of 12 patients were included in the study, of which 75% were males and 25% females. The mean age of patients was 52.92 (±10.92) years. Two patients were excluded from the study, one because of a perforation of the LRI incision during surgery and the other because of radial extension of capsulotomy leading to posterior capsule rupture. In

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the first case, suturing of wound was performed and the other case was converted to manual SICS.

There was significant improvement in BCVA at all follow-up evaluations. Average preoperative BSCVA was 0.87 ±0.48 logMAR reaching 0.14 ±0.13 logMAR at 1st postoperative day and 0.16 ±0.25 logMAR at 3rd postoperative week. Uncorrected visual acuity (UCVA) was 1.06 (±0.46) logMAR preoperatively reaching 0.28 ±0.18 logMAR at 1st postoperative day and 0.30 ±0.27 logMAR at 3rd postoperative week (Table 1).

Table 1
Visual acuity results (logMAR)

	Pre-op	post-op day	week post-op
UCVA	1.06 (±0.46)	0.28 (±0.18)	0.30 (±0.27)
BCVA	0.87 (±0.48)	0.14 (±0.13)	0.16 (±0.25)

Table 2
Pre- and post-op mean keratometric astigmatism

	Mean astigmatism (D)	Axis (degree)
Pre-operative	2.08 (± 1.05)	149.17 (± 41.22)
Day 1 post-op	1.74 (± 1.32)	112.92 (± 33.87)
3rd week post-op	1.05 (± 0.68)	114.83 (± 33.29)

Mean keratometric astigmatism reduced during the whole study period (Table 2). The mean surgically-induced astigmatism (SIA) was 2.97 ± 1.72 D at 1st postoperative day and reduced to 2.26 (±0.87) D at 3rd postoperative weeks. The induced angles of error were 103.25 ± 56.57 and 107.08 (±49.96) degree whereas intended angles of error were respectively 6.53 ±9.61 and 2.90 (±7.87) degree at 1st day and 3rd week postoperatively (Table 3).

Table 3
Mean SIA on 1st post-op day and 3rd post-operative week

Parameters	1st post-op Day	3rd week post-op
SIA (Diopter)	2.97 ± 1.72	2.26 ±0.87
SIA (Degrees)	103.25 ± 56.57	107.08 ±49.96
Angle of error (Degree)	6.53 ±9.61	2.90 ±7.87

Table 4
vector analysis of postoperative astigmatism

Parameters	1st post-op Day	3rd week post-op
TAT	1.73±0.83	1.73±0.83
SIA	2.97 ± 1.72	2.26 ±0.87
ME	+1.23±1.82	+0.38±0.88

TAT = target astigmatic treatment; SIA = surgical induced astigmatism; ME = magnitude of error

The effectiveness of the LRI combined with phacoemulsification is shown as the difference between the SIA and TAT and expressed as ME (Table 4). By definition, the smaller the ME the more effective is the LRI. Also to be noted is the fact that if the ME is negative, there is a tendency for under correction whereas a positive ME indicates overcorrection. It was found that there were minimum post-operative complications with one patient having ARMD and another with tilted PCIOL due to deformed haptic. The patient with tilted PCIOL had a lower uncorrected visual outcome of 1.00 logMAR (6/60) which was not associated with surgically induced corneal astigmatism.

Discussion
In this study, we used limbal relaxing incision in conjunction with phacoemulsification to correct preoperative astigmatism and found that it reduced significantly the mean keratometric astigmatism over a period of time. The mean SIA at 3rd week postoperatively (2.26 ±0.87D) was slightly higher compared to the postoperative astigmatism of 1.53 ±0.68 D at one month in the study of Carvalho et al (2007), 1.48 (±2.87) D at one month in the study of Budak et al (2001) and 1.21 diopter at 6 weeks in that of Kaufmann (2005). The follow-up period in our study is comparatively short and the number of patients is also small, which could have resulted in skewing of the data towards the few who had high SIA. The short follow up could also have resulted in incomplete regression and ongoing wound healing. Budak et al (2001) reported that regression in astigmatic correction mostly occurs in eyes with more than 3.50 D of astigmatism and between the first and third postoperative months

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The uncorrected visual acuity improved from 1.06 (±0.46) logMAR preoperatively to 0.28 (±0.18) logMAR on the 1st day postoperatively and to 0.30 (±0.27) logMAR at the 3rd week postoperatively. Again, the BCVA improved from 0.87 (±0.48) logMAR preoperatively to 0.14 (±0.13) logMAR on 1st postoperative day and 0.16 (±0.25) logMAR on 3rd week postoperative. There was significant improvement in UCVA from the preoperative to the 1st postoperative day but not much change thereafter. This signifies that corneal aberration, if any, produced by LRI does not have much significance on the visual acuity of the eye (Carvalho et al 2007).

The other significant change was induced angle of error, which was 6.53 ±9.61 degrees on 1st postoperative day while it became 2.90 ±7.87degree on the 3rd postoperative week. It is less than 15.8 degrees at 1 month postoperatively, as reported by Carvalho and co workers (Carvalho et al 2007). Though our study shows the mean angle of error to be small we observed that it was large in patients with high preoperative ATR as compared to those with high WTR and small ATR patients. This may be due to the fact that when making larger arc incisions, the incision does not remain parallel to the limbus, due to the surgeon error and the oval anatomy of the limbus. Also, it was found that there may be significant amount of globe rotation in patients with peribulbar blocks and when positioned in the supine position. Therefore, it is imperative to mark the horizontal axis in the sitting position preoperatively, preferably on the slit-lamp.

We used keratometric astigmatism in this study, the result of which is comparable to the mean keratometric astigmatism of corneal topography in the study of Steinert, 2004. Although all patients who underwent LRI had reduction in astigmatism, a trend towards overcorrection was found, which was different from other studies where they found the majority of patients had under correction (Bayramlar et al 2003, Carvalho et al 2007). In our study, the mean magnitude of error on the 1st postoperative day was +1.23 (±1.82) D and decreased to +0.38 (±0.88) D on the 3rd week postoperatively. Out of the 12 patients, only 4 had under correction and one had full astigmatic correction (ME=0). We also found that a higher degree of over-correction was seen in patients with higher dioptres of against-the-rule-astigmatism. This could be due to the

fact that we were using the temporal approach for the phaco procedure which required combination of the phaco incision within the LRI. This would lead to a hinge type of incision that has a greater flattening affect on the corneal curvature. The higher degree of astigmatism (ATR) would mean a larger incision arc that could lead to a greater degree of surgical error in the initial cases of LRI. Limbal relaxing incisions are more effective if used with cataract surgery than used alone for primary astigmatism. (Bayramlar et al 2003).

The per-operative complication rate of LRI patients was very low. We had one case of corneal perforation while performing LRI. The wound was sutured with 10-0 nylon and the suture was removed after one and half months. The patient's UCVA was 0.3 logMAR (6/12) and BSCVA was 0.2 logMAR (6/9) after three and half months postoperatively. The other patient with mature cataract had CCC extension leading to posterior capsule rupture during surgery and phacoemulsification was converted into Manual SICS. Both patients were excluded from the study. There were no significant postoperative complications related to the LRI procedure, except for one patient having pre-existing ARMD and the other with tilted PCIOL due to deformation of the haptic.

The major limitations of the study were the comparatively short follow-up and the small number of patients. Of 17 patients' files reviewed, two were excluded due to complications and three did not complete a minimum follow-up period of 3 weeks. We feel that in the future a prospective, well designed and larger study with adequate follow-up would generate better understanding of the effect of LRI in treating pre-existing astigmatism in cataract patients.

Conclusion
In our early experience with LRI, we found that it is an effective method to treat preoperative corneal astigmatism with good predictability of the angle. We continue to use it to treat one diopter or more of astigmatism in cataract patients in combination with phacoemulsification. For patients with less than one diopter of preoperative astigmatism, we employ the OAI technique.

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