Addis Ababa University

College of health sciences

School of Medicine

Department of Ophthalmology

Refractive Outcome of Manual Small Incision Cataract Surgery in tertiary teaching Hospital

BY: FISIHA ADEME, MD (OPHTHALMOLOGY RESIDENT, ADDIS ABABA UNIVERSITY, SCHOOL OF MEDICINE, DEPARTMENT OF OPHTHALMOLOGY)

Clinical Research submitted for the fulfillment of postgraduate program in Ophthalmology

2024 GC

Addis Ababa, Ethiopia

Addis Ababa University
College of health sciences
School of Medicine
Department of Ophthalmology

Refractive Outcome of Manual Small Incision Cataract Surgery in tertiary teaching Hospital

Investigator: Fisiha Ademe, MD (Ophthalmology resident, Addis Ababa University, School of Medicine, Department of Ophthalmology)

Advisors

1. Abeba Teklegiorgis M.D (Associate professor of Ophthalmology, Addis Ababa University, School of Medicine, Department of Ophthalmology)
2. Alemayehu Weldeyes, M.D (Assistant professor of ophthalmology, Addis Ababa University, School of Medicine, Department of Ophthalmology)

2024 GC
Addis Ababa, Ethiopia

Acknowledgements

I would like to convey my deepest gratitude to Nurse Yohannes Araya and Nurse Fitihalew Adinew whose dedicated assistance in data collection were crucial for the successful implementation of this study.

I am truly thankful to all those who contributed to this endeavor, and I hope the findings from this study will help advance the understanding and address the critical issue of refractive outcome after MSICS in Menelik tertiary eye care center and beyond.

Table of Contents

Acronyms

AL------Axial length

ATR----Against the rule

BCVA---best corrected visual acuity

CA----Corneal astigmatism

D-------Diopter

IOL------Intraocular lens

K1-----Vertical corneal power

K2-----Horizontal corneal power

MSICS---Manual small incision cataract surgery

PCI------ Partial coherence interferometer

PCRIs----- Peripheral corneal relaxing incisions

SE--------Spherical equivalent

SIA------Surgically induced astigmatism

UCVA----uncorrected visual acuity

VA-------Visual acuity

WTR----With the rule

List of tables and figures

Abstract

Background: Cataract remains a leading cause of blindness globally, particularly in developing countries. Manual Small Incision Cataract Surgery (MSICS) has emerged as an effective and cost-efficient technique for cataract removal. However, concerns regarding postoperative refractive outcomes persist.

Objective: This study aims to evaluate the refractive outcome after MSICS at Menelik II Referral Hospital, Addis Ababa, Ethiopia.

Methods: A hospital based longitudinal study was conducted involving 385 MSICS patients followed up at 4-6 weeks post op. Data on sociodemographic characteristics, preoperative biometry, surgical details, and postoperative visual acuity and biometry profile were collected. Refractive outcomes were measured based on pre operative biometry and post operative biometry after 4 weeks post-surgery.

Results: The median age was 65 years, with 60% female participants. The majority of surgeries utilized straight scleral incisions, and the most common intraoperative complication was posterior capsular tear (7.5%). Postoperatively, 73.8% achieved best-corrected visual acuity (BCVA) better than 6/18, but only 53.2% reached target refraction within ±1.0 D. The surgically induced astigmatism for the operated eyes was found to be 0.75 D ± 1.38 D. A significant inverse relationship was found between surgically induced astigmatism (SIA) and the likelihood of achieving target refraction. (OR = 0.707, 95% CI: 0.564 - 0.885, p = 0.002), and a protective pattern between scleral incision size ≤8mm and achieving target refraction (OR = 11.850, 95% CI: 5.447 – 25.778, p = <0.001).

Conclusion: MSICS demonstrates favorable visual outcomes with a significant proportion of patients achieving optimal refractive results. Understanding the determinants of refractive outcomes in this context can enhance surgical practices and improve patient satisfaction in cataract surgery. Further research is warranted to establish best practices tailored to the Ethiopian healthcare setting.

.....

Key words: Manual Small Incision Cataract Surgery (MSICS), Refractive outcomes, surgically induced astigmatism

1. Introduction

1.1 Background

Globally, there are at least 1 billion individuals who have untreated or preventable vision impairment, cataract and uncorrected refractive error being the main causes. (1) In terms of relative contribution to age-standardized prevalence of total blindness in persons aged 50 years and older, cataract caused 45.5% of all global blindness. (2) According to Ethiopia's National Survey on Blindness, Low Vision, and Trachoma from 2006, the prevalence of blindness is 1.6%, with cataracts accounting for 49.9% of cases. (3)

The only proven way of treatment when a cataract becomes visually significant is cataract surgery, which is one of the most common procedures performed worldwide since oldest time. (4)

Modern cataract surgery has evolved through time in the past four decades, from intracapsular cataract extraction (ICCE) to extracapsular cataract extraction (ECCE) and phacoemulsification with IOL implantation. ((5–7)) Despite phacoemulsification is the standard procedure in developed countries, manual small incision cataract surgery (MSICS) has become the preferred procedure in developing countries due to its cheaper, faster alternative which requires less technology and training. (6–8))

Despite advances in surgical techniques and technology, refractive errors that develop postoperatively and residual astigmatism are a major concern for cataract surgeons since they have a poor impact on visual acuity (VA) and patient satisfaction. Studies recommend the site of corneal incision selection to be based on the steeper axis of corneal astigmatism in order to reduce surgically induced astigmatism or even to attain astigmatic neutrality and aim for spectacle independence. ((9–12))

2. Literature review

Modern cataract surgery raises concerns about refractive error brought on by remaining corneal astigmatism. ((11),(12,13))

Impact of laterality on refractive outcome after MSICS

A descriptive cross-sectional study on the refractive outcome of cataract surgery done at university of Gondar tertiary eyecare and training center, Ethiopia in 2019 included 90 eyes of 66 patients. Among these, only 58 (64.4%) eyes met their target refraction of ±1.00 diopter (D) post-operatively. No statistically significant variation in the mean SE in eyes with different AL measurement. No statistically significant difference was observed in the mean SE between the left and right eye as well. (14)

In another retrospective study in Australia on the corneal flattening effect of small incision cataract surgery on the left and right eye, revealed that in comparison, temporal incisions between the paired eyes where there is > 0.5 D preoperative astigmatism, the flattening effect in the right eye was statistically significantly larger than the left eye Where as in case of the superior incisions there was no statistically significant difference noted. (15)

Impact of incision location on refractive outcome after MSICS

A study from India comparing the astigmatism caused by a superior, supero-temporal, and temporal incision in manual SICS, the temporal and superotemporal groups had less induced astigmatism than the superior group and the superotemporal and temporal groups has a comparable induced astigmatism.(9) and In contrary to this a study in Gondar, Ethiopia, has not found a statistical difference on the post operative mean refractive error between the temporal and superior approach.(14)

In another study in Ghana on the postoperative corneal and surgically induced astigmatism following superior approach cataract surgery (MSICS) revealed that the postoperative corneal

astigmatism for ATR astigmatism cataract patients who underwent superior approach MSICS was statistically and clinically significantly greater than preoperative corneal astigmatism. (11)

Impact of incision type on refractive outcome after MSICS

A prospective cross-sectional study was done in India in 2014 to determine the surgically induced astigmatism among three different incision types (straight, frown and chevron) in MSICS. The study revealed that patients in chevron incision achieved the lowest mean SIA (-0.88±0.61D×90 degrees) which was statistically significant and patients in straight group has achieved the highest mean SIA value (-1.08±0.67 D). (16)

Another prospective study from Ghana regarding corneal astigmatism following frown and straight incision in MSICS showed the mean residual corneal astigmatism values for the frown incision group were roughly twice as high as those for the straight incision group. (1.00±0.12 D for the frown incision group, and 0.50±0.12 D for the straight incision group) however there was no statically significant difference in the preoperative and residual corneal astigmatism between the incision groups. (17)

3. Objectives

3.1. General Objective

- To determine the Refractive Outcome of cataract surgery (MSICS) at Menelik II tertiary teaching center, Addis Ababa, Ethiopia

3.2. Specific Objectives

- To determine the refractive outcome after cataract surgery (MSICS)
- To determine surgically induced corneal astigmatism after MSICS
- To determine factors affecting the post operative refractive outcome after MSICS

4. Methodology

4.1. Study Setting

The study was conducted in Menelik II Referral Hospital, and Addis Ababa, Ethiopia. Menelik II Hospital is a Tertiary eye care center which is found in the capital city of Ethiopia, Addis Ababa. In the center, currently there are 24 senior ophthalmologists, and 9 ophthalmology 3rd and 4th senior residents. The ophthalmology operating theatre has seven functional operating tables, and on average 150 adult cataract cases are operated monthly by ophthalmologists and senior ophthalmology residents under supervision.

4.2. Study design

Hospital based longitudinal study at Menelik II referral hospital, Addis Ababa, Ethiopia.

4.3. Target population

All individuals who underwent manual small incision cataract surgery in Menelik II referral hospital tertiary eye care center

4.4. Study population

All consecutive patients above the age of 18 years who underwent MSICS at Menelik II referral hospital, by senior ophthalmologists and ophthalmology residents.

4.5. Exclusion and Inclusion criteria

4.5.1. Inclusion criteria

All cataract patients above the age of 18 years who underwent MSICS was included in the study.

4.5.2. Exclusion criteria

Patients with incomplete biometry measurement, Patients who were scheduled for more than one simultaneous ocular surgery (combined surgeries), patients with prior ocular surgery for other ocular illness like retinal, glaucoma, corneal surgery, and patients who were unable to come for follow up in the first 4 to 6 weeks after the procedure were excluded from the study.

4.6. Sample size determination and sampling technique

4.6.1. Sampling technique

Using single population proportion formula, with a prevalence rate of 50%, a confidence level of 95%, and a margin of error of 5%, a sample size of approximately **385** participants is taken.

4.7. Study period

This study was conducted from April 2024– September 2024

4.8. Data collection procedure

For those patients that fulfilled the inclusion criteria, the purpose of the study was explained and written informed consent was obtained from each patient. Relevant sociodemographic data, presenting UCVA and BCVA, biometry profile and refraction status of the of the eye to be operated on was extracted from patient pre operative chart.

Intra operative data, including scleral incision width (measured with a caliper), incision type and location, inserted IOL power and location of the IOL was filled. All surgeries done by resident doctors were done under supervision by senior ophthalmologists. Most surgeries done by final year residents were independent surgeries, whereas third year residents surgeries were adjoint surgeries with ophthalmologists.

Post operative data, including UCVA and BCVA, biometry profile of the operated eye was collected by the principal investigator. After patient's 1st post operation week visit their next appointment date was acquired from the appointment logbook, for those patients with unregistered appointment date a phone call was made to inform their coming appointment timeline counting their 4 – 6 post op weeks from the date of surgery for refraction and keratometry measurement. Dilated exam was done to evaluate IOL centration.

The preoperative and the postoperative K1 and K2 reading and refraction was taken through auto Refractor-keratometer NIDEK model AR-20ST1 in five measurements and the average K1 and K2 value was taken and the pre operative axial length measurement was taken by an PACSCAN

PLUS Sonomed contact A-scan ultrasound model 300A+. The IOL measurement was taken by using SRK/T formula a pre-installed application to the PACSCAN PLUS machine.

A structured questionnaire was used to collect all patient data.

4.9. Variables and Operational definitions

The independent variables include age of the patient, laterality of the cataract, preoperative refraction, technique of biometry measurement including IOL calculation and power, corneal incision location, type and size, the experience of the surgeon and postoperative complications including posterior capsular rupture and IOL position or centration.

- **K1**: Curvature of cornea along the vertical meridian
- **K2**: curvature of cornea along the horizontal meridian
- **With-the-rule (WTR)** when the axis of correcting minus cylinder is within 30˚ of the vertical 90˚meridian,
- **Against-the-rule (ATR)** when the correcting minus cylinder axis is within 30˚of the horizontal 180˚, and
- **Preoperative corneal astigmatism** is determined as the initial difference between K-reading values for the two principal corneal meridians of each participant's eye before surgery
- **The Residual corneal astigmatism** is the difference between preoperative keratometry reading and postoperative keratometry reading between the 4^{th} to 6^{th} postoperative week.
- **Scleral tunnel incisions**
    I. **Straight shaped incision**: a scleral incision which is linear
    II. **Frown shaped incision**: When the incision is made antiparallel to limbus
- **Visual outcome:**
    - Good outcome – post operative VA≥ 6/18
    - Poor outcome – post operative VA <6/60

4.10 Data processing and analysis

The difference in the preoperative and postoperative K1 and K2 value was used to calculate the mean surgically induced astigmatism. Spherical equivalent of the spherical and

astigmatic correction of the post operative refraction was calculated to obtain the number of eyes that met the target refraction. Data was then entered and analyzed with SPSS version 27. The median, standard deviation of continuous variables and frequency of categorical variables was determined, multivariate logistic regression was conducted to look for association between the independent variables and the target refraction and multiple linear regression was computed to see the relation between independent variables and SIA. P value less than 0.05 was considered statistically significant.

The independent variables that were examined for association were, age, sex laterality of the operated eye, axial length of the operated eye, scleral incision width, type and location, whether suture was used to close the scleral incision, selected intraoperative complications and difference in calculated and inserted IOL. The study's main outcome measures were surgically induced astigmatism and post operative spherical equivalent measured after 4^{th} -6^{th} week post operation.

4.11. Ethical considerations

Research proposal was submitted to the department of ophthalmology research and publication committee for approval. A written and informed consent sheet was attached to the questionnaire and provided to the participant after detail elaboration about the purpose of the study. Each patient's data was kept in a password secured folder to ensure confidentiality.

4.12. Dissemination plan

The findings of this study was presented to the department of ophthalmology at Menelik II tertiary training center, Addis Ababa Ethiopia, in the presence of all consultants and resident Doctors. It can be presented to national and/or regional conference. The research paper will be sent to local and /international journals for Publication of the study findings.

5. Result

Sociodemographic characteristics

The study included a total of 385 eyes, 154 (40%) male and 231 (60%) female with a median age of 65 years (range 18 - 94 years). Eighty percent cases were between the age of 50 – 80 years, (Table 1) Forty-two percent of the whole cases traveled from out of the city to get their surgeries done.

Table 1 SDC of cataract operated eyes by SICS. n=143

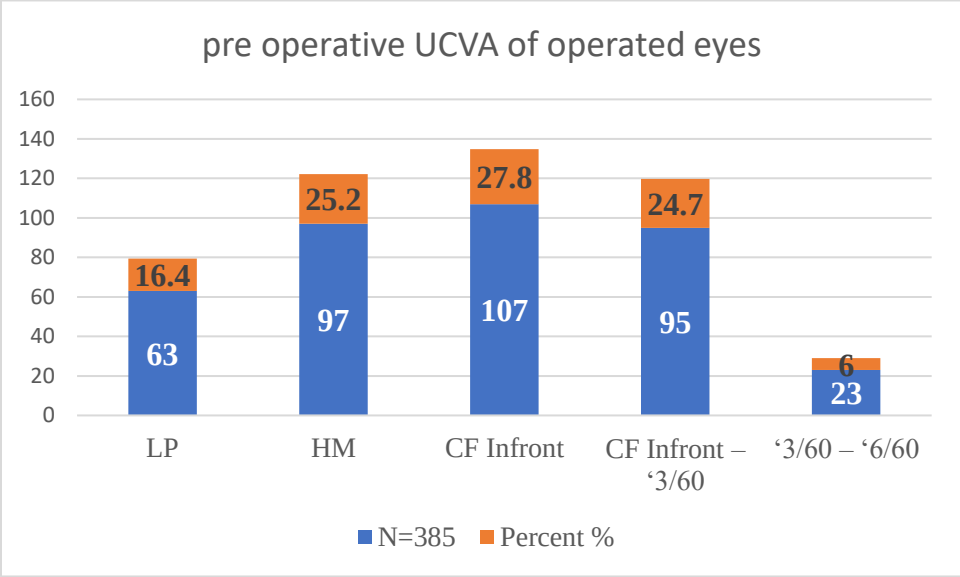
Age (in years)	**n(%)**
<20	1 (0.3)
20-30	5 (1.3)
31-40	17 (4.4)
41-50	39 (10.1)
51-60	89 (23.1)
61-70	127 (33.0)
71-80	84 (21.8)
81-90	21 (5.5)
>90	2 (0.5)
Total	385 (100)

n: number of subjects in an age group.

Preoperative profile

Among the operated eyes which fulfilled the inclusion criteria 189 (49.1%) of them were right eyes and 196 (50.9%) were left eyes and all cases had UCVA (uncorrected visual acuity) of 6/60, with 94% of these had VA worse than 3/60. (Fig. 2)

Figure 4 Uncorrected visual acuity (UCVA) of eyes to be operated among study participants.



*LP= perception of light, HM= hand motion, CF=finger counting

The pre operative mean biometry profile of the right and the left eyes respectively was, AL (axial length) = 23.20mm / 23.18mm, K1 (vertical meridian corneal power) = 43.36D / 43.26D, K2 (horizontal meridian corneal power) = 44.37D / 44.34D, calculated IOL (intra ocular lens) = 21.04D / 21.40D.

The mean pre operative K1 and K2 measured values for male and female was, K1= 42.76D (SD of 1.81) / 43.68D (1.89) and K2= 43.87D (SD of 1.96) / 44.68D (SD of 1.89) respectively. There was no statistically significant difference in axial length and keratometric value of the left and right eyes and between the two sexes.

Fifty-two eyes had an AL measurement <22mm, of these 84.6% were females with statistically significant difference for AL ≤22mm between male and female (p=0.01). Twenty-four eyes had AL measurement >25mm, with no statistically significant difference between the two sexes.

Intraoperative profile

The majority of the scleral incisions fell within the 6-7 mm range, with 193 cases (50.1%). Over all 319 (2.9%) of cases falling within the 6-8 mm range. (figure 3)

More than three fourth of operated cases (81.3%) were approached through a straight scleral incision approach and 18.7% of them were approached through a frown scleral incision. Three

Hundred fifty-eight cases (93%) were operated through a superior incision, 15 (3.9%) through a temporal incision and 12 (3.1%) through a superotemporal incision. Eighty three percent of the eyes had scleral incision width in the range of 6- 8mm, and 17% of the eyes had incision width greater than 8mm. Scleral suture was applied to 40 (10.4%) cases to close the scleral main incision wound and for the 376 (97.6%) of cases IOL was inserted in the posterior chamber, 1 case IOL was inserted in the Anterior chamber with a total mean calculated IOL of 21.38D and a total of 8 cases were left aphakic, 4 cases were left aphakic intentionally due to absence of a minus power IOL in the market and 4 cases due to intraoperative complications.

PC (posterior capsular) tear was the commonest complication noted with 7.5% of the total cases followed by premature AC entry in 4 of operated cases, and nucleus and IOL drop in 2 cases (1 case each).

The exact calculated IOL power was inserted in only 254 eyes (67.4%) out of 377 cases where IOL was inserted. In 99 cases (26.3%), the IOL inserted was within ±0.5D of the preoperatively calculated power. In 14 cases (3.7%), the inserted IOL differed by 1.0D from the calculated power. The remaining 10 cases had a difference of more than 1.0D. This was due to the absence of the calculated IOL in the market or store at the time of surgery.

Post operative profile

Among all operated eyes 164 (42.6%) of the them achieved UCVA better than 6/18 and 284 (73.8%) eyes achieved BCVA better than 6/18. Thirty-nine eyes (10.1%) achieved a UCVA worse than 6/60 and Thirty (7.8%) of them achieved worse than 6/60 after best spectacle correction.

The post operative mean biometry profile of the right and the left eyes respectively was, K1 (vertical meridian corneal power) = 42.71 (SD= 2.14) / 42.75 (SD=2.10), K2 (horizontal meridian corneal power) = 44.51 (SD=2.24) / 44.47 (SD=2.15), calculated IOL (intra ocular lens) = 21.18D (SD=3.29) / 21.57D (SD=2.54). there was no statistically significant difference in the mean keratometric value of the two eyes.

The mean difference between the pre operative and post operative keratometry measurements was -0.58 (95% CI -0.71 to -0.46) for K1 and 0.14 (95% CI 0.12 - 0.26) for K2. The difference between the pre-op and post-op Keratometry measurement was found to be statistically significant. (Table 2)

Table 2 Paired sample t-test of pre op and post op K1 and K2 measurements

	BIOMETRY PROFILE	**MEAN**	**SD**	**95% CONFIDENCE INTERVAL OF THE DIFFERENCE**		**SIG. (2-TAILED)**
				Lower	Upper	
PAIR 1	K1 post op – K1 pre op	-0.58216	1.22798	-0.70521	-0.45911	<0.01
PAIR 2	K2 post op – K2 pre op	0.13558	1.23240	0.1209	0.25908	0.031

The mean surgically induced astigmatism for the operated eyes was found to be 0.75 D ± 1.38 D. A multinomial logistic regression analysis was performed to assess the influence of various factors on surgical induced astigmatism. The model included the following variables: eye to be operated on (OD/OS), scleral incision width, incision type, incision location, suture usage, and presence of intraoperative complications and axial length. (Table 3)

Eyes operated with scleral incision Width ≤8mm were more likely to have a lower surgically induced astigmatism than those with >8 mm with the OR of 4.90 (CI: 1.14, 20.99; p = 0.032). Not using sutures to close the scleral incision wound, has a lower surgically induced astigmatism outcome OR of 3.968 (CI: 1.510, 10.428), p=0.005.

Due to smaller number of observations for temporal and superotemporal incision location, Fischer's exact test was computed and there was no association found (p=0.057).

Table 3 a Logistic regression analysis of SIA and associated factors.

Variable	***SIA Group 1 (SIA < 1D)**		***SIA Group 2 (SIA 1-3D)**	
	OR (CI)	****p-value**	**OR (CI)**	**p-value**
Eye to be operated (OD vs. OS)	0.821 (0.453, 1.456)	0.514	1.842 (0.910, 3.728)	0.090
Incision Type (straight vs. frown)	0.787 (0.352, 1.760)	0.559	1.416 (0.603, 3.329)	0.425
Incision Location (Superior)	0.966 (0.106, 8.836)	0.975	0.211 (0.023, 1.896)	0.165
Incision Location (Temporal)	1.985 (0.114, 34.4)	0.638	1.117 (0.063, 19.888)	0.940
Is Suture Used (No vs. Yes)	3.968 (1.510, 10.428)	**0.005**	2.305 (0.728, 7.298)	0.156
Intra OP Complication (No vs. Yes)	1.627 (0.646, 4.094)	0.301	1.203 (0.394, 3.677)	0.745
Scleral Incision width (≤8mm vs. >8mm)	2.217 (1.060, 4.637)	**0.034**	1.416 (0.603, 3.329)	0.425
Axial length <22mm	3.015 (0.747, 12.160)	0.121	1.30 (0.260, 6.510)	0.749
Axial length 22-25 mm	2.234 (0.704, 7.085)	0.172	1.303 (0.353, 4.811)	0.691

- ***SIA Groups:** The SIA groups represent surgical induced astigmatism categorized as follows: Group 1 (SIA ≤ 1D), Group 2 (SIA 1-2D), and Group 3 (> 2D).
- ****p-value:** values less than 0.05 considered statistically significant.

Of all operated eyes only 53.2% of them achieved the target refraction with in ±1.0 D, and the mean SE (spherical equivalent) was -0.7389 and -0.7352 for the right and for the left eye respectively. No statistically significant difference was seen whether the operated eye was right or left. A large proportion of the operated eyes had a post op myopic spherical equivalent. (table 4)

Surgically induced astigmatism (SIA) is found to have statistically significant association with target SE. A univariate binary logistic regression showed, eyes with high SIA are linked with a decreased likelihood of achieving the target refractive outcome.

Table 4 Refractive outcome of cataract operated eyes after SICS at Menilik Hospital.

Spherical equivalent (SE) in D	Frequency/percent		n=385
	OD n=69	OS=74	
>1.00 D	16 (4.2%)	14 (3.6%)	30 (7.8%)
±1.00 D	97 (40.6%)	108 (40.5%)	205 (53.2%)
< -1.00 D	76 (19.7%)	74 (19.2%)	150 (38.9%)

A binary logistic regression analysis was performed to assess the influence of various factors on the likelihood of attaining the target SE. The model included the following variables: eye to be operated on (OD/OS), axial length (AL), scleral incision width, incision type, incision location, suture usage, presence of intraoperative complications, and surgically induced astigmatism.

We found a significant inverse relationship between target SE and SIA (OR = 0. 707, 95% CI: 0.564 - 0.885). This indicates that higher SIA levels are associated with lower chances of attaining target SE (p=0.002). (Table 5)

AL measurement between 22mm-25mm and scleral incision width below 8mm show a protective pattern, however hyperopic eyes had low likelihood of attaining target SE (p-0.007). No statistically significant association was found among the other independent variables. (Table 5)

Table 5 Logistic regression analysis of target refractive outcome and associated factors.

Variables	**Descriptions**	**OR**	**95% C.I.**		**P value**
			Lower	Upper	
Eye to be operated (1)	OD	1.061	0.679	1.658	0.795
AL	22mm -25mm	1			**0.002**
AL (1)	<22mm	0.202	0.064	0.640	**0.007**
AL (2)	>25mm	0.654	0.247	1.732	0.393

Scleral incision horizontal width	≤8mm	11.850	5.447	25.778	**<0.001**
Incision type (1)	Frown scleral incision	1.651	0.936	2.914	0.083
Incision Location	Superior incision	1			0.186
Incision Location (1)	Temporal incision	1.262	0.371	4.296	0.710
Incision Location (2)	Superotemporal incision	4.701	0.726	30.424	0.104
Is Suture used? (1)	Suture used to close the scleral wound	1.365	0.593	3.146	0.465
Is there Intra OP complication (1)	Complication present	1.129	0.511	2.497	0.764
SIA	Surgically induced astigmatism	0.707	0.564	0.885	**0.002**

*AL=axial length, p value <0.05 is taken as statistically significant

Neither incision type nor location showed significant associations with the target SE. The use of sutures did not significantly affect the outcome (B = 0.234, p = 0.465). Intraoperative Complications also did not have a significant impact on the target SE (B = 0.163, p = 0.764). No significant effect was found for the laterality of the eye operated (B = 0.025, p = 0.795).

6. Discussion

Modern cataract surgeries primary objectives are to restore patients' vision and achieve on-target refraction. However, despite advances in surgical techniques and technology, refractive errors that develop postoperatively and residual astigmatism are a major concern for cataract surgeons since they have an impact on visual acuity (VA) and patient satisfaction. There are A number of pre-, intra-, and post-operative factors that influence refractive outcomes after cataract surgery. (18,19) Our study aimed to determine the effect of pre-, intra, and post operative factors on the refractive outcome of MSICS done in Menelik II tertiary eye care center.

SOCIODEMOGRAPHIC AND PRE-OPERATIVE PROFILE

In this study, 385 cataract surgeries operated with in the study period were included. Out of these 58% were from the capital city and majority of the cases were above the age of 50 years old with comparable female to male ratio (1.3 to 1). All cases had uncorrected visual acuity (UCVA) of 6/60 or worse and 362 eyes (94.1%) had UCVA of worse than 3/60 prior to the cataract surgery. This is consistent with previous studies done in Ethiopia at different eye care centers.(14,20,21) This may account to patients from the rural areas only seeking medical attention when the vision impairment impedes them from functioning the daily activities and also usually cataract surgery is prioritized to those with severe visual impairment due to the burden of cataract patients and its demand.

Overall, 90.1% of eyes had against the rule astigmatism (ATR) preoperatively considering the age of the participants this is consistent with previous studies that has shown a shift to ATR astigmatism as we age due to the weight of the eyelid and gravity deforming the cornea. (22,23)
Our results indicated no statistically significant difference in keratometry biometry profiles between sexes or eye laterality, however among eyes with small AL measurement (≤22mm) female patients account for 84.6%, which was a statistically significant difference (p=0.01).

INTRAOPERATIVE PROFILE

We tried to involve MSICS done by different level of expertise, categorized into 1. senior ophthalmologist, 2. Final year resident doctors in training, 3. Third year resident doctors in training. 52.2% were operated by ophthalmologists, and 47.8% of eyes were operated by resident doctors in training. PC (posterior capsular) tear was the commonest complication noted in 7.5% of operated eyes. This finding is comparable to rate of PC tear comparing recorded with previous studies from different eye care institutions in the country (5% to 6.1%)(20,21) and a study from Nigeria (6%) (24), and comparatively lower rate than another multicenter study from Nigeria (14.6%) (25), whereas it was higher rate than an institutional based study from India (0.6%). (8) The higher rate observed in our study compared to the Indian institution might be due to differences in surgical training environments as residents are required to do a number of ECCE procedures prior to performing MSICS procedures where as in our center MSICS is the routine and the only cataract extraction procedure available for resident doctors for training: the result could also be attributed to differences in patient profile between the two set ups.

Majority (82.9%) of scleral incisions were in the range of 6-8mm which aligns with established best practices, emphasizing the importance of standardized techniques in enhancing surgical success.(26)

POST OPERATIVE PROFILE

Two hundred eighty-four eyes (73.8%) of eyes had good visual outcome with refraction which is significantly better when compared to previous study done at Menelik hospital (63.4%) (27) and other eye care centers in the country, Jimma university hospital (70.4%), St Paul Medical college (68.5%) (20,21) and comparable to a study from Nigeria (24) however it was lower than a study done in university of Gondar (82.2%) and study from Vivekananda Polyclinic and Institute of Medical Sciences Lucknow, India (93.1%). (14,16) This observed difference could be attributed to a difference in patient selection, intra-op or post op complications or how well the patients are optically corrected. Thirty (7.8%) of them had 6/60 or worse post operative visual acuity (VA) with no improvement with refraction, this might be attributed to preexisting ocular conditions like age related macular degeneration, diabetic retinopathy or glaucoma.

Only 205 (53.2%) of the operated eyes achieved the target refraction with in ±1.0 D, which is significantly lower than the standard set for refractive outcome after cataract surgery by NHS.

(28) Our finding is also lower than a similar study done in university of Gondar in which 64.4 % of the operated eyes achieved a target refraction.(14) This difference could be attributed to differences in level of surgeon experience. All cataract surgeries were done by senior ophthalmologists in the later study, where as in our study eyes were operated by resident doctors in training and senior ophthalmologists which would have significant effect on the outcome.

In our study, the mean surgically induced astigmatism (SIA) was found to be 0.75 D, this can be considered a moderate level of SIA comparing to reported studies showing mean SIA values in a range of 0.5 D to 1.9 D in MSICS and phacoemulsification surgeries. (16–18). There was no statistically significant difference between incision types (frown and straight incision) nor among the different incision locations (temporal, superotemporal and superior). Similarly no statistically significant difference was reported between frown and straight incision in studies from Ghana and India (16,17), however the premise from previous studies is that frown incision provide a lesser post operative astigmatism.(12,29) while we did not find a difference in SIA between different locations in our study, other studies revealed that superior incision resulted in significantly more SIA than temporal incision (9,12,18). These differences may be attributed to factors such as the surgical technique employed, or surgeon experience which could influence outcomes. In addition, in our study the protective trend observed in patients with axial lengths between 22-25 mm suggests that anatomical considerations could play a role in surgical planning and outcomes.

FACTORS AFFECTING REFRACTIVE OUTCOME

We have found a significant inverse relationship between SIA and the likelihood of achieving target refraction, suggesting that higher levels of SIA are associated with poorer refractive outcomes. Additionally, larger incision widths were significantly associated with decreased odds of achieving target outcomes, emphasizing the importance of incision technique in minimizing postoperative astigmatism.

Remarkably, SIA and spherical equivalent did not significantly correlate with incision type, or location.

7. Strengths and Limitations

The study addresses a critical public health concern in Ethiopia, where cataract remains the leading cause of reversible blindness. The study also examines a number of factors impacting refractive outcomes, including patient demographics, and surgical techniques, in order to provide a thorough picture of the procedure's efficacy. In addition, the outcomes might lead to better surgical methods, happier patients, and provide a baseline audit for refractive outcomes of cataract surgery in Menelik tertiary eye care hospital, which is currently lacking.

The limitation of the study may include, first, the study did not take the variation in surgical techniques among different surgeons in to consideration which might impact the generalizability of the outcome regarding the preset premises for factors such as incision type and location relations with the surgically induced astigmatism in previous studies. Second, the pre operative refractive error of the patients was largely unknown because subjective refraction was not done due to the dense cataract. This made it challenging to assess the impact of the surgery on the preexisting refractive error of patients, and the impact of preexisting refractive error in attaining the standard target SE.

8. Conclusion and Recommendations

8.1 Conclusion

The study highlighted the effectiveness of MSICS on improving the visual outcome of patients. The study has also shown the significance of surgical technique on refractive outcome following MSICS, by extrapolating the influence of factors like size of scleral incision width and surgically induced astigmatism on attaining target refraction. Even though the overall visual outcome is encouraging there is still room for improvement specially in surgical training and patient selection as evidenced by the lower rate of achieved target refraction.

8.2 Recommendations

Based on the findings of our study we recommend implementing customized standardized protocols for preoperative biometry and IOL power calculation for patients to ensure measurement consistency and accuracy. The findings also indicate that larger incision widths correlate with poorer refractive outcomes so establishing guidelines for optimal scleral incision could improve results.

Competing interests

The authors declare that they have no competing interests

9. References

1. WHO. World report on vision. Geneva: World Health Organization, 2019 https://www.who.int/publications-detail-redirect/world-report-on-vision.

2. GBD 2019 Blindness and Vision Impairment Collaborators; Vision Loss Expert Group of the Global Burden of Disease Study. Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. Lancet Glob Health. 2021 Feb;9(2):e144-e160. doi: 10.1016/S2214-109X(20)30489-7. Epub 2020 Dec 1. Erratum in: Lancet Glob Health. 2021 Apr;9(4):e408. PMID: 33275949; PMCID: PMC7820391.

3. Berhane Y, Worku A, Bejiga A, et al. Prevalence and causes of blindness and low vision in Ethiopia.Ethiop J Health Dev.2008;21(3):204–210. doi: 10.4314/ejhd.v21i3.10050.

4. Davis G. The Evolution of Cataract Surgery. Mo Med. 2016 Jan-Feb;113(1):58-62. PMID: 27039493; PMCID: PMC6139750.

5. Linebarger EJ, Hardten DR, Shah GK, Lindstrom RL. Phacoemulsification and modern cataract surgery. Surv Ophthalmol. 1999 Sep-Oct;44(2):123-47. doi: 10.1016/s0039-6257(99)00085-5. PMID: 10541151.

6. Tabin G, Chen M, Espandar L. Cataract surgery for the developing world. Curr Opin Ophthalmol. 2008 Jan;19(1):55-9. doi: 10.1097/ICU.0b013e3282f154bd. PMID: 18090899.

7. Gogate PM, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi SA, Palimkar A, Deshpande MD. Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized controlled clinical trial: six-week results. Ophthalmology. 2005 May;112(5):869-74. doi: 10.1016/j.ophtha.2004.11.055. PMID: 15878068.

8. Haripriya A, Chang DF, Reena M, Shekhar M. Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye Hospital. J Cataract Refract Surg. 2012 Aug;38(8):1360-9. doi: 10.1016/j.jcrs.2012.04.025. PMID: 22814042.

9. Gokhale NS, Sawhney S. Reduction in astigmatism in manual small incision cataract surgery through change of incision site. Indian J Ophthalmol. 2005 Sep;53(3):201-3. doi: 10.4103/0301-4738.16684. PMID: 16137970.

10. Singh K, Misbah A, Saluja P, Singh AK. Review of manual small-incision cataract surgery. Indian J Ophthalmol. 2017 Dec;65(12):1281-1288. doi: 10.4103/ijo.IJO_863_17. PMID: 29208807; PMCID: PMC5742955.

11. Arthur E, Sadik AA, Kumah DB, Osae EA, Mireku FA, Asiedu FY, Ablordeppey RK. Postoperative Corneal and Surgically Induced Astigmatism following Superior Approach Manual Small Incision Cataract Surgery in Patients with Preoperative Against-the-Rule Astigmatism. J Ophthalmol. 2016;2016:9489036. doi: 10.1155/2016/9489036. Epub 2016 Dec 28. PMID: 28116142; PMCID: PMC5225371.

12. Mallik VK, Kumar S, Kamboj R, Jain C, Jain K, Kumar S. Comparison of astigmatism following manual small incision cataract surgery: superior versus temporal approach. Nepal J Ophthalmol. 2012 Jan-Jun;4(1):54-8. doi: 10.3126/nepjoph.v4i1.5851. Erratum in: Nepal J Ophthalmol. 2012 Jul-Dec;4(2):343. PMID: 22343997.

13. Amesbury EC, Miller KM. Correction of astigmatism at the time of cataract surgery. Curr Opin Ophthalmol. 2009 Jan;20(1):19-24. doi: 10.1097/ICU.0b013e328319c27a. PMID: 19077825.

14. Mengistu M, Admassu F, Wondale T, Tsegaw A. Refractive Outcome of Cataract Surgery Done at University of Gondar Tertiary Eye Care and Training Center, North West Ethiopia. Patient Relat Outcome Meas. 2021;12:173-179 https://doi.org/10.2147/PROM.S308816.

15. Alpins N, Ong JK, Stamatelatos G. Asymmetric Corneal Flattening Effect After Small Incision Cataract Surgery. J Refract Surg. 2016 Aug 1;32(9):598-603. doi: 10.3928/1081597X-20160608-01. PMID: 27598729.

16. Jauhari N, Chopra D, Chaurasia RK, Agarwal A. Comparison of surgically induced astigmatism in various incisions in manual small incision cataract surgery. Int J Ophthalmol. 2014 Dec 18;7(6):1001-4. doi: 10.3980/j.issn.2222-3959.2014.06.16. PMID: 25540754; PMCID: PMC4270965.

17. Amedo AO, Amoah K, Koomson NY, Ben Kumah D, Osae EA. Assessment of corneal astigmatism following frown and straight incision forms in sutureless manual small incision cataract surgery. Clin Optom (Auckl). 2016 Apr 22;8:47-52. doi: 10.2147/OPTO.S98920. PMID: 30214348; PMCID: PMC6095366.

18. Reddy B, Raj A, Singh VP. Site of incision and corneal astigmatism in conventional SICS versus phacoemulsification. Ann Ophthalmol (Skokie). 2007 Fall;39(3):209-16. doi: 10.1007/s12009-007-0020-y. PMID: 18025627.

19. Khoramnia R, Auffarth G, Łabuz G, Pettit G, Suryakumar R. Refractive Outcomes after Cataract Surgery. Diagnostics (Basel). 2022 Jan 19;12(2):243. doi: 10.3390/diagnostics12020243. PMID: 35204334; PMCID: PMC8870878.

20. Addisu Z, Solomon B. Patients' Preoperative Expectation and Outcome of Cataract Surgery at Jimma University Specialized Hospital-Department of Ophthalmology. Ethiop J Health Sci. 2011 Aug 26;21(1):47–56.

21. Markos CM, Tamrat LT, Asferaw MA. Outcomes and Associated Factors of Cataract Surgery Among Adults Attending a Tertiary Hospital in Addis Ababa, Ethiopia. Patient Relat Outcome Meas. 2020;11:231–9.

22. Lyle WM. Changes in corneal astigmatism with age. Am J Optom Arch Am Acad Optom. 1971 Jun;48(6):467-78. doi: 10.1097/00006324-197106000-00002. PMID: 5281065.

23. Wu Z, Liu C, Chen Z. Prevalence and Age-Related Changes of Corneal Astigmatism in Patients Undergoing Cataract Surgery in Northern China. J Ophthalmol. 2020 Sep 29;2020:6385098. doi: 10.1155/2020/6385098. PMID: 33062314; PMCID: PMC7542495.

24. Olawoye OO, Ashaye AO, Bekibele CO, Ajayi BGK. Visual outcome after cataract surgery at the university college hospital, ibadan. Ann Ib Postgrad Med. 2011 Jun;9(1):8–13.

25. Odugbo OP, Babalola OE, Morgan RE. Influence of rank of surgeon on the outcome of cataract surgery in Plateau State Nigeria. Jos J Med. 2011;5(2):212–216.

26. Venkatesh R, Chang DF, Muralikrishnan R, Hemal K, Gogate P, Sengupta S. Manual Small Incision Cataract Surgery: A Review. Asia-Pac J Ophthalmol. 2012;1(2):113–9.

27. Haileselassie T, Asefa Y, Bayu S, Bejiga A. Outcome of extra-capsular cataract extraction with posterior chamber intraocular lens implantation performed at a cataract surgical campaign. Ethiop J Health Dev. 2002 Jan 1;16(1):77–83.

28. Gale RP, Saldana M, Johnston RL, Zuberbuhler B, McKibbin M. Benchmark standards for refractive outcomes after NHS cataract surgery. Eye (Lond). 2009 Jan;23(1):149-52. doi: 10.1038/sj.eye.6702954. Epub 2007 Aug 24. PMID: 17721503.

29. Chourasia P, Kumar G, Kumar S. Comparison of Surgically Induced Astigmatism in Manual Small Incision Cataract Surgery Following Straight Versus Frown Incision. Int J Res Rev. 2019;6(9):328–36.