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Research Article

Refractive Results, Visual Outcomes, and Predictive Error in Patients Undergoing Cataract Surgery with Manual Small Incision Surgery

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Abstract

Purpose: To describe the refractive and visual outcomes and the predictive error in patients that underwent cataract surgery with manual small incision technique (M-SICS) in ophthalmology clinic Sala Uno.

Setting: Sala uno Ophthalmology Clinic, Cataract and refractive surgery department, Mexico City, Mexico.

Methods: A retrospective analysis was performed, which included 99 eyes with an axial length (AL) from 22 to 25 mm with M-SICS technique and intraocular lens implantation (IOL) of polymethylmethacrylate in the bag. Preoperative AL was measured by interferometry. IOL power was calculated with the SRK/T formula. Patients had a complete ophthalmic examination, preoperatively and 30 days after surgery. Postoperative visual capacity was documented, the reached spherical equivalent (SE) and the predictive error (PE) were calculated. Statistical analysis was performed with SPSS V25.

Results: The visual capacity 30 days after having performed the surgery was 0.1 ± 0.1 LogMar, the mean refraction in SE was -0.420 ± 0.443 diopters. The PE was 0.096 ± 0.441 diopters, 97% of the patients achieved a postoperative refractive result within 1.0 D of the target refraction.

Conclusion: The M-SICS technique offers very good postoperative visual and refractive results in average eyes.

Keywords: Cataract, Predictive Error; Refractive Outcomes; Visual Outcomes; M-SICS; Small Incision

Abbreviations

M-SICS: Manual Small Incision Cataract Surgery; IOL: Intraocular Lens; D: Diopter; PE: Predictive Error; SE: Spherical Equivalent; LogMAR: Logarithm of the Minimum Angle of Resolution

Introduction

Cataracts stand as a leading cause of reversible blindness globally, accounting for 41% to 68% of all cases of reversible blindness in Latin America [1]. Given that cataract surgery allows for the reversal of visual impairment, efforts are made daily to provide the best possible visual acuity post-surgery to enable independence from corrective lenses. Achieving this necessitates precise biometry and adequate selection of the optimal intraocular lens (IOL) power [2,3].

Projections indicate a 25% increase in demand for cataract surgery in the next 10 years and a 50% surge in the following 20 years, underscoring the importance of ensuring patient access to cataract surgery [4]. Presently, phacoemulsification stands as the preferred surgery, with over 85% of cases demonstrating refractive outcomes within 1.0 diopter (D) of the target refraction [2]. However, manual small incision cataract surgery (M-SICS) has emerged as a viable surgical alternative. M-SICS involves a scleral incision ranging from 6 mm to 6.5 mm, large enough to allow manual extraction of the cataract followed by the insertion of an IOL [5]. This technique has gained popularity due to its affordability, delivering visual outcomes similar to phacoemulsification, while also requiring less time and a shorter learning curve [5].

Predictive error (PE) represents the difference, in diopters expressed as spherical equivalent (SE), between the actual postoperative refractive outcome and the anticipated outcome from IOL calculation. A negative PE implies a myopic outcome compared to the anticipated, while a positive PE denotes a hyperopic outcome in relation to the expected result. A PE of zero signifies no disparity between the postoperative and expected outcome.3 Modern optical biometry can achieve PE outcomes of over 90% within ±1 D and over 60% within ±0.5 D of the target [2].

In some countries like the United Kingdom, achieving an 85% rate of PEs within ±1 D of the target is considered a quality standard for phacoemulsification, with 55% falling within ±0.5 D of the target [6]. A recent study documented that, following an intensive biometry course, this same target was met with M-SICS, wherein up to 90% of eyes achieved results within ±1.0 D of the target spherical equivalent [3]. However, these findings lack documentation in other publications and, to our knowledge, no reports exist within the Mexican population. Thus, the study aims to describe refractive, visual outcomes, and predictive error in cataract-operated patients using the SICS technique at Ophthalmology Clinic Sala Uno.

Materials and Methods

A cross-sectional, analytical, retrospective, and observational study was conducted at the surgical center of the Sala Uno Ophthalmological Clinic in Mexico City. Electronic medical records on the Salesforce® platform were reviewed for patients who underwent M-SICS surgery at the clinic from May to August 2019. Ninety-nine eyes from 94 patients were identified and included in the study. These patients had an axial length between 22 to 25 mm, keratometric astigmatism less than or equal to 1.25 D, and documented preoperative, postoperative, and postoperative refractive visual acuity. Patients with ocular comorbidities affecting vision and those with trans or postoperative complications were excluded.

Intraocular lens power calculation

The IOL Master 700 was used to measure axial length and keratometry. Subsequently, the Ultra-compact A/B/P ultrasound system from Quantel Medical was used for intraocular lens (IOL) power calculation using the SRK/T formula. The implanted IOL in all patients was the Aurolens S3602 (Aurolab), a rigid polymethyl methacrylate lens with a constant of 118.5. The target refraction in spherical equivalent (SE) was individually chosen for each patient, with an average of -0.324 ± 0.099 D.

Surgical technique

M-SICS surgeries were performed by two expert surgeons using the same technique. This involved limbal conjunctival peritomy, followed by a straight scleral incision located approximately 3 mm from the limbus. A two-plane sclerocorneal tunnel was created without entering the anterior chamber, and an accessory port was opened with a 2.8 mm clear corneal blade. Trypan blue was instilled for anterior capsule staining, followed by rinsing with balanced saline solution, and filling the anterior chamber with viscoelastic (1.6% sodium hyaluronate, Aurolab). A wide continuous circular capsulorhexis was performed, the third plane of the sclerocorneal tunnel was opened with a 2.8 mm blade, and hydrodissection and/or viscodissection were performed to prolapse the lens into the anterior chamber. Viscoelastic was injected above and below the nucleus for extraction using a vectis. The Simcoe cannula was used to aspirate cortical remnants. The capsular bag was filled with viscoelastic, and the rigid PMMA IOL was placed inside the capsular bag.

Results and Discussion

General characteristics of the sample

Ninety-nine eyes of 94 patients who underwent cataract surgery using the M-SICS technique were studied. Left eyes constituted 50.5% of the sample. Regarding gender, 64% of the patients were female. The average age of the patients was 70 ± 10 years, with a range from 48 to 92 years. Half of the patients were under 71 years old. When classifying patients in decade age groups, 34% were between 65 and 74 years, while only 3% were under 55 years.

While evaluating the axial length, the average was 23.3 ± 0.7 mm. It is essential to note that the enrollment criteria for axial length ranged from a minimum of 22 mm to a maximum of 25 mm.

Visual and refractive results

To analyze the impact of the treatment (cataract surgery through M-SICS), the preoperative visual capacity (VC) was recorded, as well as at the one-month postoperative mark. Additionally, the postoperative refractive outcome, objective refraction, and predictive error were documented. Based on these data, the following results were obtained:

Visual results

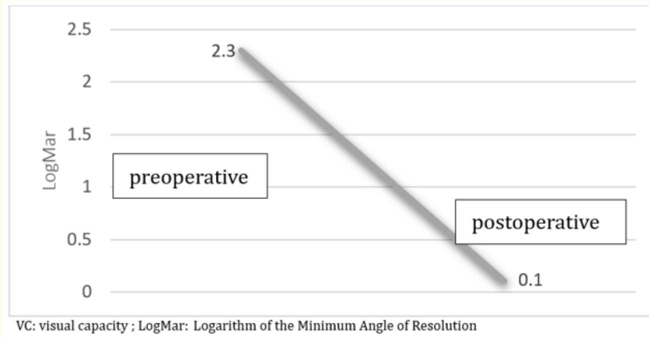
Visual capacity

- **Preoperative:** The average preoperative VC was 2.3 ± 1 logMAR, with a range between 0.5 and 3.1 logMAR. Thus, 63% of patients had visual capacity worse than 20/2000, and 4% were between 20/640 and 20/2000 in Snellen notation.
- **Postoperative (Day 30):** The average postoperative visual acuity was 0.1 ± 0.1 logMAR, with a minimum value of 0.0 logMAR and a maximum of 0.3 logMAR. Therefore, 67% of patients achieved visual acuity between 20/22 and 20/30 in the postoperative evaluation in Snellen notation.

Based on the above, an improvement in patients' visual capacity (VC) was observed in post-treatment measurements. Therefore, a comparison was made between preoperative and postoperative measurements. This difference was analyzed using the paired-samples t-test, revealing a mean difference of 2.2 ± 1 logMAR. The difference was statistically significant ($t = -22.288$, $df = 98$, $p < 0.05$). This is summarized in Graphic 1 and Table 1, displaying the averages of the two assessments to observe their trend following the intervention.

Refractive results

As mentioned earlier, refractive outcomes were evaluated at the first postoperative month, recording sphere and cylinder values, and converting them to SE. Additionally, the predicted refraction (target) was documented, and the predictive error was calculated, yielding the following results.



Graphic 1: Average Values of VC According to Evaluation Time.

Evaluation of VC in LogMar			
Preoperative	Postoperative	Dif.	P
2.3	0.1	2.2	>0.5

Table 1: Average values of VC and their difference according to the evaluation time.

Sphere

The average value was 0.04 ± 0.46 D, ranging from -1.5 to +1.0 D. 40% of the operated patients had residual hypermetropia, and 25% ended up with a neutral sphere.

Astigmatism

- **Preoperative:** The average value of keratometric astigmatism measured by IOL Master 700 was -0.69 ± 0.28 D, with a range of values from 0.0 to -1.15 D.
- **Postoperative:** The average value using subjective refraction was -0.93 ± 0.48 D, ranging from 0 to -2.50 D.

Thus, it was observed that the trend in astigmatism values was towards an increase, showing a difference between the averages of both measurements of 0.24 ± 0.58 D. This difference was statistically significant, as analyzed by the paired Student's t-test ($t = -4.007$ $df = 98$, $p < 0.05$). This is exemplified in Table 2.

Astigmatism Assessment			
Preoperative	Postoperative	Dif.	P
0.69	0.93	-0.24	<0.5

Table 2: Average Astigmatism Values and their Difference Based on Evaluation Time.

Spherical equivalent

- **Predicted Spherical Equivalent (Target):** The average value was -0.32 ± 0.09 D, with a minimum of -0.54 D and a maximum of -0.14 D.
- **Postoperative Spherical Equivalent:** The average value was -0.42 ± 0.44 D, ranging from -1.75 D to -0.5 D.

Based on the above, it was observed that the difference between the means was 0.09 ± 0.44 D, which when evaluated using the Student's t-test for paired samples, was determined to be statistically significant (t = 2.168, df = 98, $p < 0.05$) (Table 3).

Refraction			
Target	Postoperative	Dif.	P
-0.324	-0.420	0.096	<0.5

Table 3: Average refraction values and their difference according to evaluation time.

Predictive error

It was found that the average of this was 0.09 ± 0.44 D, with a minimum value of -0.76 D and a maximum of 1.44 D. 97% of the eyes were within a range of ± 1.00 D of difference between the postoperative SE and the predicted refractive error (target). 45.5% of the patients were within ± 0.25 D. Only 3% obtained a PE greater than -1.00 D (Table 4).

Range of SE (D)	n	%
Within ± 0.25	45	45.5%
Within ± 0.50	75	75.8%
Within ± 1.00	96	97.0%
Greater than -1.00	3	3.0%

Table 4: Distribution of Predictive Error.

Discussion

Cataract surgery using the manual small incision cataract surgery (M-SICS) technique has demonstrated comparable results to phacoemulsification in various publications. In this study, refractive and visual outcomes were found to be similar, with a prediction error within the standard reference point for phacoemulsification (≥85% within ±1.00 D of PE).

In terms of visual outcomes, 98% of patients achieved visual acuity ≥20/30, and 100% achieved ≥20/40 in expert hands. In a study in Sonora, Mexico, 88.23% achieved visual acuity ≥20/40, with 74.50% achieving 20/20 visual acuity in the hands of residents. Other studies report visual acuity ≥20/40 in 94-97.1% of surgeries performed by expert surgeons.

One of the significant findings in this study was a prediction accuracy of 45.5% for refractive errors of ± 0.25 D, 75.8% for ± 0.50 D, and 97% for ± 1.00 D. A study by Meyer., *et al*. in patients undergoing M-SICS found that the mean prediction error of IOL calculations decreased by 50% after a biometry training course. They reported that a higher percentage of eyes (52.5%) had a postoperative spherical equivalent within ± 0.5 D and 90.0% within ± 1.0 D of the predicted postoperative spherical equivalent.

Refractive examination one month after surgery revealed that 40% of patients had hyperopia with a PE of 0.09 ± 0.44 D, similar to Meyer's study, who found a prediction error of 0.56 ± 0.44 D. To our knowledge, no other study reports predictive error in patients operated on for cataracts using the M-SICS technique.

Regarding astigmatism, preoperative measurements were keratometric astigmatism, and postoperative measurements were obtained through subjective refraction, showing a difference of 0.24 ± 0.58 D. Although this difference was statistically significant, it is important to note potential inaccuracies due to the difference in methods used before and after surgery.

Conclusion

This study demonstrated that visual outcomes with cataract surgery using the M-SICS technique are excellent, predictable, and consistent. This highlights the reliability and utility of interferometry-based measurements of keratometry and axial length for calculating IOL power with the SRK/T formula in eyes with axial lengths between 22 mm and 25 mm undergoing M-SICS.

Using this methodology for lens calculation and the M-SICS surgical technique, visual results of ≥20/40 were achieved in 100% of analyzed patients, and results better than ≥20/30 were achieved in 98% of patients without transoperative or postoperative complications. Additionally, a prediction error of ± 1.00 D was reached in 97%, consistent with the quality standard for cataract surgery visual outcomes reported in the literature.

With these results, the aim is to promote greater acceptance and application of M-SICS in ophthalmological centers, contributing to combating cataract blindness in Mexico and improving the quality of life for more people.

Furthermore, conducting similar studies on eyes with different axial lengths than those studied here and employing alternative lens calculation methods (equipment and/or formulas) would provide more information regarding the predictability of M-SICS results and clarify its utility in eyes outside the average size range.

Conflict of Interest

Authors have no conflict of interest or any financial interest to declare.

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