

Impact of Cataract Severity on Measurement Acquisition with the Lenstar LS 900 Biometer in a Tertiary Care Centre

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Abstract

Background: Accurate ocular biometry is essential for precise intraocular lens power calculation. Increasing cataract density may reduce optical signal transmission and cause measurement failure with the Lenstar LS 900 biometer. This study evaluated the effect of cataract severity and morphology on Lenstar measurement acquisition. **Material and Methods:** This prospective observational study included 120 eyes of patients aged ≥ 40 years with cataract, evaluated over a period of 3 months from June to August 2026. Cataract severity was graded using LOCS III. Optical biometry was performed using the Lenstar LS 900 after pupillary dilation. Successful acquisition was defined by a reproducible retinal pigment epithelium peak with valid axial length and keratometry measurements. Ultrasound A-scan was used when optical acquisition failed. **Results:** Successful Lenstar acquisition was achieved in 101 eyes (84.2%), while 19 eyes (15.8%) had acquisition failure. Failure increased with increasing cataract severity, with higher LOCS III scores observed in failed acquisitions. Posterior subcapsular and mature cataracts showed the highest frequency of acquisition failure. Ultrasound A-scan provided an alternative for eyes with unsuccessful optical acquisition. **Conclusion:** Mature/very dense and posterior subcapsular cataracts showed the highest failure rates of optical biometry acquisition. Ultrasound A-scan remains a useful alternative when reliable optical biometry cannot be obtained.

Keywords: Lenstar LS 900; Optical biometry; Cataract severity; LOCS III; Measurement failure; Ultrasound A-scan.

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INTRODUCTION

Cataract remains one of the major causes of visual impairment worldwide, and cataract surgery has evolved from restoration of vision to a refractive procedure in which accurate prediction of postoperative refraction is an important determinant of patient satisfaction. Precise preoperative ocular biometry is therefore essential for appropriate intraocular lens (IOL) power calculation. Errors in axial length (AL), corneal power, and estimation of postoperative IOL position can contribute substantially to refractive prediction error.^[1-3]

Optical biometry has largely replaced contact ultrasound biometry in routine cataract practice because it is non-contact, reproducible, and capable of providing highly precise ocular measurements. Partial-coherence interferometry represented an important advance in optical biometry and demonstrated substantially greater precision than conventional ultrasound measurements.^[4] However, optical measurement can be limited when the ocular media are sufficiently opaque to attenuate or scatter the measurement signal.

The Lens Opacities Classification System III (LOCS III) is a standardized method for grading cataract severity based on nuclear opacity/color, cortical opacity, and posterior subcapsular cataract (PSC).^[5] LOCS III has demonstrated

good reproducibility, although appropriate observer standardization is important for improving interobserver agreement.^[6,7] Objective assessment of cataract severity using a standardized grading system is therefore useful when studying the influence of lens opacity on optical biometry.

The Lenstar LS 900 (Haag-Streit AG, Koniz, Switzerland) is an optical low-coherence reflectometry (OLCR)-based biometer capable of simultaneously acquiring multiple ocular biometric parameters, including axial length, anterior chamber depth, lens thickness, keratometry, central corneal thickness, and white-to-white distance. Early studies demonstrated good agreement, repeatability, and clinical usefulness of Lenstar measurements compared with established optical and ultrasound techniques.^[8-11]

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Despite these advantages, acquisition of axial length may become difficult or impossible in eyes with advanced cataract. Buckhurst et al. reported that the Lenstar was unable to obtain measurements in a proportion of eyes with dense media opacity.^[8] Similarly, studies evaluating acquisition rates in cataractous eyes have demonstrated that optical measurement success can decrease with increasing cataract severity.^[12] McAlinden et al., in a study specifically evaluating the IOLMaster and Lenstar LS 900, reported overall failure rates of 37.84% and 35.47%, respectively, and found that increasing PSC severity was significantly associated with failure of Lenstar acquisition.^[13]

The mechanism underlying this limitation is related to attenuation and scattering of the optical signal by an increasingly opaque crystalline lens. Posterior subcapsular opacity may be particularly problematic because of its location along the visual axis and its potential to interfere with transmission of the measurement beam. In eyes with dense cataract in which optical biometry is unsuccessful, ultrasound biometry may provide an alternative method of obtaining axial length measurements.^[14] A dedicated dense-cataract measurement mode has also been developed for the Lenstar LS 900 to improve acquisition in eyes in which standard optical measurement fails.^[15]

More recently, swept-source optical coherence tomography (SS-OCT)-based biometers have demonstrated improved measurement acquisition in eyes with dense cataract compared with older-generation optical technologies. Comparative studies have shown that SS-OCT devices can successfully measure eyes in which PCI or OLCR devices fail, including eyes with dense nuclear sclerosis and large PSC.^[16-19] Meta-analytic evidence similarly suggests lower technical failure rates with SS-OCT-based biometry compared with older optical technologies.^[20]

Although several studies have evaluated Lenstar performance and optical biometry in cataractous eyes, there remains a need for studies correlating quantified cataract severity and morphology with Lenstar acquisition success, particularly using a standardized cataract grading system. The present study was therefore undertaken to evaluate the association between cataract severity, cataract morphology, LOCS III scores, and successful or failed measurement acquisition using the Lenstar LS 900 in a tertiary eye-care setting.

MATERIALS AND METHODS

Study design and setting: This hospital-based prospective observational study was conducted in the Department of Ophthalmology at Sankara Eye Hospital, Ludhiana. The study was done over a period of three months from 1 June to 31 August 2026. The study included patients presenting with cataract who were scheduled for elective cataract surgery.

Study population: Each operated eye was considered as one study unit. In patients undergoing bilateral surgery during the study period, only the first operated eye was included.

Sample size

The sample size was calculated using Cochran's formula:

$$n = \frac{Z^2pq}{d^2}$$

n = required initial sample size

Z = standard normal deviate at 95% confidence level = 1.96

p = expected proportion of Lenstar measurement failure = 16% = 0.16

q = 1 - p = 0.84

d = desired absolute precision = 7% = 0.07

With a 95% confidence level and absolute precision of 7%, the calculated minimum sample size was approximately 105 eyes. Considering possible exclusions and incomplete measurements, the final sample size was rounded to 120 eyes.

Inclusion criteria

- Patients aged ≥ 40 years.
- Age-related or secondary cataract scheduled for elective cataract surgery.
- Patients cooperative for optical biometry.
- Clear cornea permitting optical measurement.

Exclusion criteria

- Advanced keratoconus or dense corneal scarring.
- Dense vitreous haemorrhage or other media opacity independently preventing optical measurement.
- Intraocular surgery within the preceding 6 months.
- Active uveitis or severe ocular surface disease.
- Posterior segment pathology significantly affecting fixation.

Preoperative assessment: All participants underwent a comprehensive ophthalmic examination, including best-corrected visual acuity (BCVA), intraocular pressure measurement and dilated slit-lamp examination. Visual acuity was recorded using the Snellen chart and converted to logarithm of the minimum angle of resolution (LogMAR) for statistical analysis.

Pupillary dilatation was achieved using tropicamide 1% and phenylephrine 2.5%, with a minimum pupil diameter of 6 mm before optical biometry.

Cataract grading: Cataract severity and morphology were assessed using the Lens Opacities Classification System III (LOCS III). Nuclear opacity, cortical opacity and posterior subcapsular opacity were graded according to the standardized LOCS III system. Cataracts were subsequently categorized according to their predominant morphology and severity for analysis.

For analysis of cataract morphology, eyes were categorized as nuclear-predominant, cortical-predominant, PSC-predominant, or mature/very dense cataract based on the predominant clinically significant opacity. In mixed cataracts, the component considered most clinically significant by the examining ophthalmologist was used for categorization. For severity analysis, a composite cataract severity score was calculated by summing the nuclear opalescence (NO), cortical (C), and posterior subcapsular cataract (PSC) grades. This composite score was used only for analysis in the present study and does not represent an official LOCS III total score.

For the purpose of analysis, posterior subcapsular and mature cataracts were additionally recorded according to their predominant morphology. Cataract morphology was categorized as nuclear, cortical, posterior subcapsular (PSC), or

mature cataract.

The LOCS III grades were subsequently compared between eyes with successful and failed Lenstar LS 900 biometric measurement acquisition to evaluate the relationship between cataract severity and measurement acquisition.

Lenstar LS 900 biometry: Optical biometry was performed using the Lenstar LS 900 biometer (Haag-Streit Diagnostics) according to the manufacturer's standard procedure. Measurements included axial length (AL), anterior chamber depth (ACD), lens thickness (LT), keratometry (K1 and K2), white-to-white (WTW) distance and corneal astigmatism. Each parameter was measured three times with the mean values noted. In case any of the parameters had low signal to noise ratio, the measurement was repeated.

A measurement was considered successful when a distinct and repeatable retinal pigment epithelium (RPE) reflection peak was obtained, with a numerical axial length and valid average keratometry measurement.

Measurement acquisition was considered failed when the RPE signal could not be adequately resolved, the measurement field remained blank, or the instrument generated an explicit measurement error despite appropriate alignment and repeated attempts.

Ultrasound A-scan: Ultrasound A-scan was used as an alternative method for obtaining axial length measurements when optical biometry acquisition failed.

Outcome measures

The primary outcome was successful optical biometry acquisition with the Lenstar LS 900, defined by the

presence of a distinct and repeatable retinal pigment epithelium (RPE) reflection peak, a numerical axial length measurement, and valid keratometry.

Secondary outcomes included:

- Association between cataract morphology and Lenstar acquisition success.
- Association between LOCS III cataract severity and acquisition failure.
- Acquisition of K1, K2, WTW and astigmatism measurements.
- To document the need for alternative biometry, including ultrasound A-scan, in eyes in which optical biometry acquisition failed.

Statistical analysis: Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics version 26.0. Continuous variables were presented as mean with standard deviation or median with interquartile range. Categorical variables were presented as frequency and percentage.

The association between cataract severity/morphology and Lenstar acquisition success or failure was assessed using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables between successful and failed acquisition groups were compared using the independent-samples t-test or Mann-Whitney U test, depending on distribution. A p-value of <0.05 was considered statistically significant.

Ethical considerations: Approval was obtained from the Institutional Ethics Committee of Sankara Eye Hospital, Ludhiana before starting the study (SEH/LDH/EC/2026/017). Written informed consent was obtained from all participants. Patient identity and clinical information were kept confidential.

RESULTS

Table 1: Baseline characteristics and cataract severity parameters according to optical biometry acquisition status (N = 120 eyes)

Parameter (mean ± SD)	Total (n=120)	Successful (n=101)	Failed (n=19)	P value
Age (years)	67.22 ± 8.34	67.52 ± 8.54	65.58 ± 7.13	0.300
BCVA (LogMAR)	0.60 ± 0.26	0.58 ± 0.25	0.71 ± 0.28	0.072
Nuclear opalescence (NO)	3.11 ± 1.20	3.06 ± 1.17	3.37 ± 1.34	0.252
Cortical cataract (C)	2.74 ± 1.38	2.69 ± 1.36	3.01 ± 1.42	0.322
Posterior subcapsular cataract (PSC)	1.68 ± 1.43	1.19 ± 0.89	4.29 ± 0.64	<0.001
Composite LOCS III score	7.53 ± 2.54	6.84 ± 1.55	11.18 ± 2.65	<0.001

The mean age of the study population was 67.2 ± 8.3 years. There was no statistically significant difference in age between the successful and failed acquisition groups (p = 0.300). Similarly, BCVA did not differ significantly between the two groups (p = 0.072).

The mean nuclear and cortical cataract scores were slightly higher in the failed acquisition group, but these differences

were not statistically significant (p = 0.252 and p = 0.322, respectively). In contrast, the mean PSC score was significantly higher in the failed acquisition group (4.29 ± 0.64) compared with the successful acquisition group (1.19 ± 0.89; p < 0.001). The composite LOCS III score was also significantly higher in failed eyes (11.18 ± 2.65 vs. 6.84 ± 1.55; p < 0.001).

Table 2: Overall Lenstar LS 900 measurement acquisition

Lenstar outcome	Number of eyes	Percentage (%)
Successful acquisition	101	84.2
Failed acquisition	19	15.8
Total	120	100.0

Successful optical biometry acquisition was obtained in 101 of 120 eyes (84.2%), whereas acquisition failed in 19 eyes (15.8%).

Table 3: Lenstar acquisition according to PSC severity (LOCS III)

LOCS III PSC grade	Total	Successful	Failed	Failure rate (%)
≤2.5	9	8	1	11.1
2.6–3.5	6	4	2	33.3
3.6–4.5	4	0	4	100.0
>4.5	3	0	3	100.0
Total	22	12	10	45.5

PSC severity showed a progressive increase in Lenstar measurement failure. The failure rate was 11.1% in eyes with a PSC score ≤2.5 and increased to 33.3% in eyes with a score of 2.6–3.5. In eyes with PSC scores above 3.5,

failure rates were markedly higher, reaching 100% in the 3.6–4.5 and >4.5 groups. This demonstrated a strong association between increasing PSC severity and failure of Lenstar measurement acquisition.

Table 4: Lenstar acquisition according to predominant cataract morphology

Cataract morphology	Total	Successful	Failed	Failure rate (%)	P value
Nuclear-predominant	53	50	3	5.7	
Cortical-predominant	37	35	2	5.4	
PSC-predominant	22	12	10	45.5	
Mature/very dense cataract	8	4	4	50.0	
Total	120	101	19	15.8	<0.001

$$(\chi^2 = 28.628, df = 3, p = 2.68 \times 10^{-6})$$

According to predominant cataract morphology, Lenstar acquisition failure was observed most frequently in eyes with PSC-predominant cataract, with a failure rate of 45.5%. Nuclear-predominant and cortical-predominant

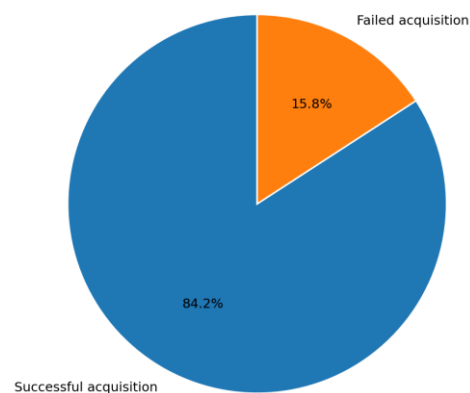
cataracts had substantially lower failure rates of 5.7% and 5.4%, respectively. Eyes with mature or very dense cataracts showed a failure rate of 50.0%.

Table 5: Comparison of LOCS III component scores between acquisition groups

LOCS III parameter	Successful (n=101)	Failed (n=19)	P value
Nuclear score	3.06 ± 1.17	3.37 ± 1.34	0.252
Cortical score	2.69 ± 1.36	3.01 ± 1.42	0.322
PSC score	1.19 ± 0.89	4.29 ± 0.64	<0.001
Composite LOCS III score	6.84 ± 1.55	11.18 ± 2.65	<0.001

The mean nuclear score was 3.06 ± 1.17 in the successful acquisition group and 3.37 ± 1.34 in the failed acquisition group, with no statistically significant difference ($p = 0.252$). Similarly, cortical scores did not differ significantly between successful and failed eyes (2.69 ± 1.36 vs. 3.01 ± 1.42; $p = 0.322$).

In contrast, the mean PSC score was markedly higher in the failed acquisition group (4.29 ± 0.64) than in the successful acquisition group (1.19 ± 0.89; $p < 0.001$). The total LOCS III score was also significantly higher in failed eyes (11.18 ± 2.65 vs. 6.84 ± 1.55; $p < 0.001$), indicating that PSC severity was the major cataract-related factor associated with Lenstar measurement failure.

Overall Lenstar LS 900 measurement acquisition**Figure 1. Overall Lenstar LS 900 measurement acquisition**

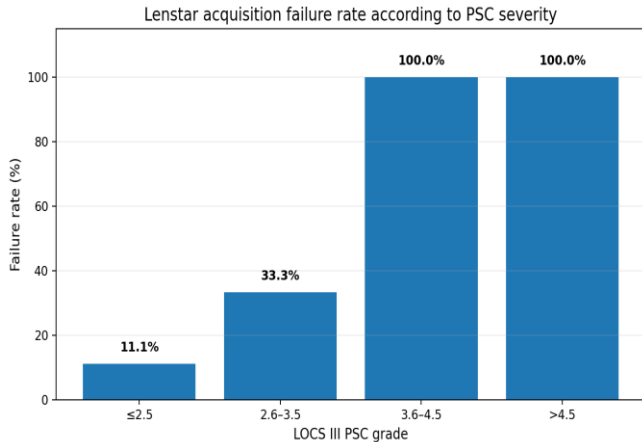


Figure 2. Lenstar acquisition according to PSC severity

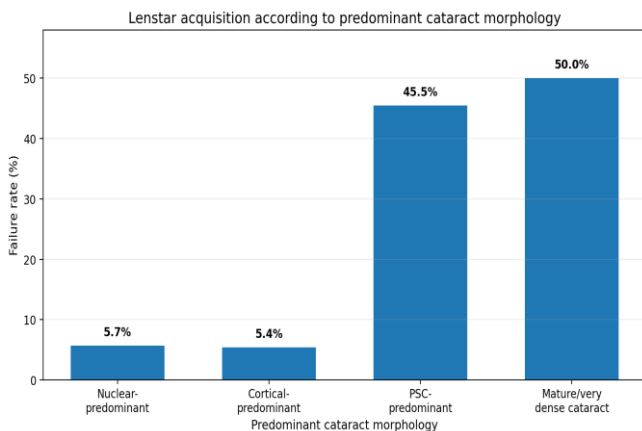


Figure 3. Lenstar acquisition according to predominant cataract morphology

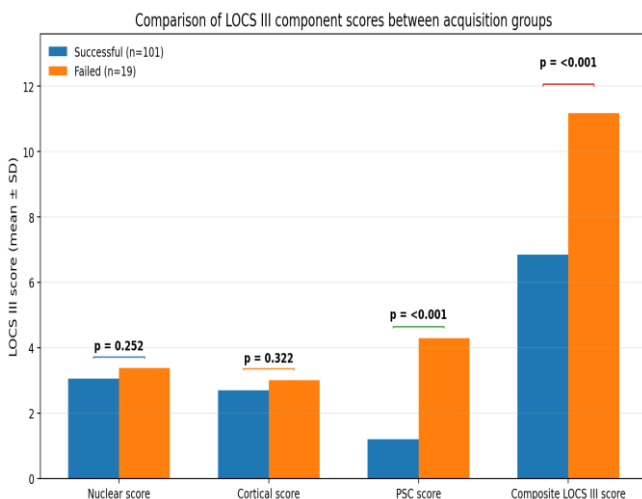


Figure 4. Comparison of LOCS III component scores between acquisition groups

DISCUSSION

The present study evaluated the effect of cataract severity and morphology on measurement acquisition using the Lenstar LS 900 optical biometer in patients undergoing

cataract evaluation. Among the 120 eyes included in the present analysis, successful biometric acquisition was obtained in 101 eyes (84.2%), whereas acquisition failed in 19 eyes (15.8%). The principal finding was that increasing cataract severity, particularly posterior subcapsular cataract (PSC), was associated with a substantially higher likelihood of failure of optical biometric acquisition. In contrast, age and baseline visual acuity did not demonstrate statistically significant differences between eyes with successful and failed measurements.

Optical biometry has become an important component of modern cataract surgery because accurate measurement of axial length and other ocular biometric parameters is essential for appropriate intraocular lens (IOL) power calculation. Errors in biometric measurements constitute an important source of postoperative refractive surprise, and even small inaccuracies in axial length, keratometry, anterior chamber depth, or lens-related measurements can influence the predicted IOL power.^[1-3] The development of non-contact optical techniques, beginning with partial coherence interferometry, represented a major advance over conventional ultrasound biometry by providing rapid, non-contact and highly reproducible measurements.^[4]

The Lenstar LS 900 uses optical low-coherence reflectometry and provides multiple biometric parameters required for IOL power calculation. Previous studies have demonstrated good repeatability and agreement of Lenstar measurements with other established optical biometry devices.^[8-11] Cruysberg et al. reported that the Lenstar LS 900 provided highly reproducible measurements, with differences from other biometric techniques that were generally not clinically significant for IOL power calculation.^[9] Similarly, studies comparing Lenstar with other optical biometers have demonstrated good agreement in axial length and other ocular biometric parameters.^[10,11,21-23] These findings support the clinical usefulness of the Lenstar LS 900 in routine cataract assessment.

Cataract severity and measurement acquisition

Despite the advantages of optical biometry, successful measurement is dependent on adequate transmission and detection of the optical signal through the ocular media. Cataractous changes can therefore interfere with acquisition, particularly when lens opacity becomes sufficiently dense to attenuate or scatter the measurement signal. In the present study, composite LOCS III severity was significantly greater in the failed-acquisition group than in the successful-acquisition group (11.18 ± 2.65 versus 6.84 ± 1.55 ; $p < 0.001$). This finding suggests that increasing lens opacity is an important determinant of the ability of the Lenstar to obtain a usable biometric signal.

The LOCS III system provides standardized grading of nuclear opacity, cortical opacity and posterior subcapsular opacity and has been widely used for objective assessment of cataract severity.^[5] Its reproducibility and clinical applicability have been demonstrated in different populations.^[5,6] However, interobserver variation may occur, particularly between observers with different levels of experience.^[7] Therefore, standardized grading and appropriate observer training are important when LOCS III scores are used to investigate the relationship between cataract severity and optical biometry.

The present findings are consistent with the broader literature demonstrating that optical biometric acquisition becomes increasingly difficult as cataract density increases. Epitropoulos reported differences in acquisition rates between optical biometers in cataractous eyes, highlighting the influence of cataract characteristics on measurement success.^[12] McAlinden et al. specifically evaluated acquisition failure in cataractous eyes using the IOLMaster and Lenstar LS 900 and demonstrated that cataract severity can substantially influence successful axial-length acquisition.^[13] Shammas et al. subsequently described a modified measurement mode for obtaining axial length in eyes with dense cataracts, emphasizing the technical challenge posed by severe media opacity.^[15]

Posterior subcapsular cataract as an important determinant

PSC showed the strongest association with optical biometry acquisition failure among the LOCS III components assessed. PSC-predominant cataracts represented 22 eyes, of which 12 had successful acquisition and 10 had failed acquisition, corresponding to a failure rate of 45.5%. Furthermore, the mean PSC grade was markedly higher in the failed group than in the successful group (4.29 ± 0.64 versus 1.19 ± 0.89 ; $p < 0.001$).

This finding is clinically plausible because PSC produces opacity close to the posterior aspect of the crystalline lens and can cause substantial light scattering despite a relatively modest overall lens opacity score. As optical biometry depends on detection of reflected optical signals from intraocular structures, increased scattering or attenuation along the optical pathway can reduce signal quality and prevent reliable identification of the retinal or other measurement peaks.

The results therefore suggest that the individual components of cataract severity may be more informative than an overall cataract score alone. In particular, a patient with a relatively moderate total cataract score but a high PSC component may have a greater risk of failed optical acquisition than a patient with predominantly nuclear or cortical changes of similar total severity. This observation is important when deciding whether an optical biometry measurement is likely to be reliable and whether an alternative measurement technique should be considered.

Nuclear cataract

Nuclear opacity was not significantly higher ($p=0.252$) in the failed-acquisition group. This distinction is important because it suggests that nuclear cataract alone may not be the principal determinant of Lenstar acquisition failure.

Cortical cataract: Similarly, cortical opacity was higher numerically in the failed-acquisition group, but the difference was not statistically significant ($p = 0.322$). This suggests that cortical cataract by itself may have a relatively limited effect on Lenstar acquisition compared with more optically disruptive forms of lens opacity.

Cataract morphology and acquisition success: When cataract morphology was considered, the acquisition failure rate was substantially greater among PSC-predominant and mature/very dense cataracts than among nuclear- or cortical-predominant cataracts. Acquisition failure occurred

in 45.5% of PSC-predominant eyes and 50% of mature/very dense cataracts, compared with 5.7% of nuclear-predominant and 5.4% of cortical-predominant eyes.

This pattern supports the hypothesis that the morphological characteristics of the cataract are more important than the mere presence of cataract in determining optical acquisition success. The findings also correspond with the established limitations of older-generation optical techniques in dense cataracts.^[13,15] When optical signal transmission becomes inadequate, alternative biometric approaches may be necessary.

Composite LOCS III score versus individual components:

The significant difference in composite LOCS III score between successful and failed acquisition groups indicates an overall relationship between cataract severity and measurement failure. However, the component-wise analysis suggests that composite LOCS III score alone may not adequately explain the mechanism of acquisition failure.

In the present study, the markedly stronger association of PSC grade with acquisition failure compared with nuclear or cortical grades suggests that component-specific grading may provide additional information when predicting the likelihood of successful optical biometry.

Therefore, rather than considering a single overall cataract severity score, clinicians may benefit from documenting the individual LOCS III components, particularly PSC severity, when optical biometry is being performed.

Relationship to previous optical biometry studies: The findings of the present study should also be considered in the context of the continuing development of optical biometric technology. Early partial coherence interferometry established the feasibility of non-contact optical axial-length measurement and subsequently became widely used in cataract surgery.^[4] The Lenstar LS 900 expanded this approach through optical low-coherence reflectometry and simultaneous acquisition of multiple biometric parameters.^[8,9]

Several studies have demonstrated agreement between Lenstar and other optical biometric devices, including the IOLMaster and newer swept-source OCT systems.^[11,16-19,21-24] However, agreement between devices in eyes where measurements can be successfully obtained does not necessarily imply equivalent acquisition rates in eyes with severe cataract. Measurement acquisition and measurement agreement are therefore two distinct aspects of biometric performance.

This distinction is particularly relevant in dense cataracts. Swept-source OCT biometers use longer-wavelength light and have demonstrated improved penetration through media opacity compared with older optical technologies.^[17-20] Kanclerz et al., in their review and meta-analysis, reported lower technical failure rates with swept-source technology compared with older-generation optical methods, supporting the increasing role of swept-source systems in challenging cataractous eyes.^[20]

Clinical implications: The findings have practical implications for cataract surgery planning. When the Lenstar LS 900 is unable to acquire reliable biometric measurements, the clinician should not simply repeat the same measurement indefinitely without assessing the cause of failure. Severe cataract, particularly prominent PSC or very dense lens opacity, should raise suspicion that optical signal attenuation is responsible for the failure.

In such cases, alternative approaches such as ultrasound biometry may be considered. Studies comparing optical low-coherence reflectometry with immersion ultrasound have demonstrated that ultrasound remains useful when optical acquisition is limited by media opacity.^[14] Similarly, specialized acquisition modes may improve the possibility of obtaining measurements in selected dense cataracts.^[15]

The availability of newer swept-source OCT biometers also provides another option in difficult cases. Studies comparing swept-source systems with older optical technologies have generally demonstrated higher acquisition success in eyes with dense cataract.^[16–20] Thus, understanding the limitations of the Lenstar LS 900 can help clinicians select an appropriate alternative before proceeding with IOL power calculation.

Importance for IOL power calculation: The clinical importance of successful biometric acquisition arises from its direct relationship with IOL power calculation. Errors in axial length and other biometric parameters are recognized contributors to postoperative refractive error.^[1–3] Modern IOL calculation therefore depends on reliable biometric measurements and appropriate prediction formulas.

Previous studies comparing Lenstar with other biometric devices have generally found good agreement and acceptable refractive outcomes.^[11,21–24] However, these advantages depend on successful acquisition of reliable measurements. If a biometric value is obtained despite poor signal quality and is subsequently used for IOL calculation without adequate verification, an incorrect IOL power may potentially be selected.

Consequently, the clinician should distinguish between an automatically generated measurement and a clinically reliable measurement. In eyes with significant cataract, repeated measurements, assessment of signal quality, comparison of biometric parameters and, where necessary, confirmation with an alternative modality can improve confidence before IOL power selection.

Age and visual acuity: Age did not differ significantly between the successful and failed acquisition groups in the present study ($p = 0.300$). This suggests that acquisition failure was more closely related to ocular media characteristics than to chronological age itself. Since cataract prevalence increases with age, age may indirectly influence acquisition failure through its association with cataract severity, but age alone is unlikely to be a direct technical determinant of optical signal acquisition.

Similarly, BCVA was not significantly different between the two groups in the revised analysis ($p = 0.072$). This is an important observation because visual acuity is influenced by several factors other than lens opacity, including corneal disease, retinal pathology, refractive error and ocular comorbidities. Therefore, visual acuity alone should not be used as a surrogate measure of cataract density or as a predictor of Lenstar acquisition success.

Repeatability and reliability of Lenstar measurements

Although the present study primarily assessed acquisition success rather than repeatability, the existing evidence supports the general reproducibility of Lenstar measurements when acquisition is successful. Cruysberg et

al. demonstrated good repeatability of the Lenstar LS 900,^[9] while other comparative studies have shown good agreement with alternative optical biometric techniques.^[10,11,21–23]

Strengths of the study: A strength of the present study is the use of LOCS III grading to characterize cataract severity and morphology. This provides a standardized framework for examining the relationship between individual types of lens opacity and biometric acquisition.^[5–7]

Another strength is the direct evaluation of successful versus failed Lenstar acquisition rather than assessing only agreement of biometric values. This approach addresses a clinically relevant problem encountered during preoperative cataract assessment.

The study also considered individual cataract components rather than relying exclusively on composite cataract severity score. The strong association observed with PSC severity provides a clinically useful hypothesis that can be investigated further in larger cohorts.

Limitations: Several limitations should be acknowledged. First, the sample size was relatively modest, particularly for the mature/very dense cataract subgroup. The small number of eyes in some categories limits the precision of subgroup estimates and may influence statistical testing.

Second, LOCS III grading is partly observer dependent, and variability between observers has been demonstrated.^[6,7] Although standardized grading can reduce this variability, some degree of measurement error may remain.

Third, the present analysis focuses primarily on acquisition success and does not evaluate the refractive accuracy of the resulting IOL power calculations. Previous studies have demonstrated that Lenstar measurements can provide reliable IOL power calculations when acquisition is successful,^[11,21–24] however, a future study should directly correlate biometric acquisition quality with postoperative refractive outcomes.

Fourth, the study did not directly compare Lenstar acquisition with ultrasound biometry or swept-source OCT in failed cases. Such a comparison would be clinically valuable because newer swept-source technologies have demonstrated improved penetration and lower technical failure rates in eyes with dense cataracts.^[16–20]

Finally, because some subgroup numbers were small, the observed failure rates should not be interpreted as definitive population estimates. Larger prospective studies are required to establish clinically useful LOCS III thresholds for predicting Lenstar acquisition failure.

CONCLUSION

Increasing cataract severity was associated with a higher likelihood of Lenstar LS 900 optical biometry acquisition failure. Posterior subcapsular cataract showed the strongest association with acquisition failure among the LOCS III components assessed, whereas nuclear and cortical cataract scores did not differ significantly between the successful and failed acquisition groups. In eyes with dense PSC or mature/very dense cataract in which optical acquisition is unsuccessful, alternative biometry such as ultrasound A-scan may be considered for obtaining axial length measurements required for intraocular lens power calculation.

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Conflicts of interest

There are no conflicts of interest.

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