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CATARACT OPERATION AFTER CORNEAL REFRACTIVE SURGERY: CURRENT EVIDENCE

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Keywords: cataract surgery, corneal refractive surgery, LASIK, PRK, SMILE, radial keratotomy, intraocular lens, IOL power calculation, total keratometry, Barrett True-K, light adjustable lens, intraoperative aberrometry.

Summary

Aim. This literature review (2021-2026) aims to examine PubMed/MEDLINE evidence regarding cataract operation after corneal refractive surgery and include evaluation of biometric data, calculation of IOL power, selection of IOLs, and managing residual refractive errors. Methods. Structured PubMed/MEDLINE search was performed using MeSH and free-text terminology relevant to cataract surgery after LASIK/PRK/SMILE, radial keratotomy, including IOL power calculations, Barrett True-K, total keratometry, intraoperative aberrometry, and light-adjustable lenses. Eligible publications (2021-2026) included; adult human studies, comparative research, systematic reviews/meta-analyses, technology assessments, and clinically oriented reviews. Results. Refractive predictability after cataract surgery is lower in post-refractive eyes than in untreated corneas due to imprecise corneal power measurements and estimates of the effective lens position. The quality of measurement (with a focus on optimizing ocular surface conditions) and the use of posterior-cornea-aware corneal power (total keratometry where possible) will improve input. Biometer-embedded Barrett True-K algorithms perform consistently across post-LASIK/PRK eyes, but post-radial keratotomy eyes remain unpredictable. Patients undergoing supplementary and/or adjustable interventions (such as LALs, corneal enhancers, or secondary IOLs) may have a reduction in their residual refractive errors. Conclusion. Cataract operation after corneal refractive surgery is generally regarded as safe, but it requires careful preoperative preparation. The most optimal practice encompasses modern corneal power calculation, IOL calculation with "no-history" and clear counselling about refractive uncertainty especially post RK.

Introduction

Corneal refractive surgery reshapes the cornea to correct ametropia, most commonly with LASIK or PRK with increasing interest in SMILE. [2,15] At the same time earlier procedures such as radial keratotomy (RK) remain clinically relevant since many elderly patients who underwent refractive surgery present for cataract surgery. [7,15] Cataract surgery is deemed safe for this demographic; however, refractive predictability may diminish due to changes in the cornea from prior refractive surgery. This affects the foundational assumptions utilized in keratometry, consequently leading to inaccuracies in intraocular lens (IOL) power calculations. [2,3]

Given that the majority of post-refractive surgery patients anticipate independence from glasses, the prevention of refractive surprises requires a systematic approach. This approach shall include: acquiring stable measurements, estimating the posterior-cornea-aware corneal power of the patient, validating the no-history method(s), and providing clear consultation to the patient about potential refractive surprises and postoperative correction. [3,12,13,7]

Aim of the Article. To summarize and analyze the evidence from PubMED/Medline (2021-2026) on cataract surgery after corneal refractive operations. This paper includes an overview of mechanisms of errors, current methods for calculating and measuring, selection of intraocular lenses, use of intraoperative adjuncts, and management of the residual refractive error.

Sources and a method of research work

A structured PubMed / MEDLINE search was performed with terms including "cataract surgery," "corneal refractive surgery," "LASIK," "PRK," "SMILE," "Radial Keratotomy," "IOL Power Calculation," "Barrett True-K," "Total Kerato-

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metry," "Light Adjustable Lens," and "Intraoperative Aberrometry." Studies of adult human subjects published in English in PubMed/MEDLINE from 2021 to 2026 that were based on either comparative studies, clinically focused reviews, technological assessments, systematic reviews/meta-analyses, or adult human clinical investigations were included.

Description of investigations

The selected research was analyzed and grouped in the major clinical areas as a narrative synthesis. The major clinical areas identified included: the quality of ocular surface and biometry; the accuracy of the estimated corneal power, including total keratometry; the use of "no-history" intraocular lens (IOL) calculation methods to account for post-refractive surgery eyes; corneal imaging-based approaches to selecting intraocular lenses; and managing any residual refractive errors.

Results of scientific activities

Ocular surface and measurement quality. Ocular surface disease (OSD) can compromise the reliability of keratometry readings and change the measured astigmatism axis thereby producing major IOL power and toric alignment errors. Therefore, the recommended approach is to identify and treat dry eye and eyelid disease before performing the final biometry measurements. As soon as the tear film becomes stable, multiple biometry should be performed to decrease variability and eliminate a misleading surgical plan. [1]

Mechanisms of IOL prediction error and posterior-cornea–aware corneal power. After the myopic ablation of the cornea conventional keratometry may misrepresent the true corneal power of the eye because conventional keratometry uses a fixed keratometric index and makes the assumption that there will be a consistent relationship between the anterior surface and the posterior surface of the cornea. This may lead to a hyperopic refractive surprise after refractive surgery, where the inaccuracy may be further exaggerated by the influence of corneal power on the ELP estimates in IOL calculations [2]. Swept-source OCT biometers can provide the total keratometry (TK) of the cornea by combining the anterior and posterior surfaces of the cornea. Standard keratometry has been shown to underestimate the refractive change when comparing pre and post refractive surgery changes (in 74 eyes utilizing the IOLMaster 700) whereas total keratometry (TK) provided a more accurate representation of the refractive change [3].

Studies have also identified that the refractive outcome following treatment for myopia via LASIK is influenced by both the IOL calculation formula used and the manner in which the corneal power is entered into the IOL calculation program, especially when the total keratometry (TK) measurement is available. One comparative study utilized nine contemporary algorithms (Barrett True-K/True-K TK, Haigis-L/Haigis TK, EVO K/EVO PK, Pearl-DGS and Hoffer QST/Hoffer QST PK) and found that the average absolute error ranged from 0.34D to 0.59D. The two groups with the lowest errors were EVO PK (0.34D) and a TK based strategy (Haigis TK) (0.40D). [4] A subsequent clinical study showed that "no history" IOL calculation formulas can produce reasonable accuracy when total keratometry (TK) is used. Barrett True-K No-History with TK produced an average absolute error of 0.42±0.34D in this group of patients; 71% of patients were within ±0.50D of their planned refractive correction and 88% were within ±1.00D of their planned refractive correction [12].

Clinical data collected during post-SMILE (small incision lenticule extraction) cases show that both posterior-cornea-aware measurements and advanced modeling techniques are required to accurately predict the refraction of the patient's eye after cataract surgery and to accurately measure the refraction in post-SMILE patients. Ray tracing provided very accurate results (i.e., approximately 83% of the eyes were within ±0.5 diopters) compared to TK-based formulas that illustrated intermediate results (approximately 67% of eyes were within ±0.5 diopters). This proves that the most accurate prediction of refraction in post-SMILE patients can only be obtained when a comprehensive assessment of the cornea is made. [5]

No-history formulas, post-RK planning, and IOL choice. No-history strategies provide a foundation when refractive history is missing. A comparative study demonstrated that Barrett True-K (biometer-only) was equivalent in outcome to a multi-formula method while streamlining the process [6].

Further comparative studies support this direction of research; the Shammas and Barrett True-K TK/no-history methods using the ASCRS calculator for post-myopic laser refractive surgery patients resulted in lower median absolute error than previously used keratometry based methods [16]. A strategy to select multi-formula approaches based on biometric values has been proposed as a way to increase accuracy in specific sub-groups [17]. Furthermore, a Bayesian network meta-analysis of post-myopia LASIK eyes found that Barrett True-K No-History, OCT-based methods, and Masket-type adjustment were among the top performers thus supporting the role of adjustment-based approaches within this population [14]

In contrast, post-RK eyes continue to be the most difficult to predict due to irregular optic and refractive instability. A 2024 cohort study continues to demonstrate the challenges

of selecting IOLs for post-RK patients and supports conservative targeting practices and explicit counseling [7]. Consistent with this variability a 2026 Bayesian network meta-analysis in post-RK cohorts supports the conclusion that no one formula will dominate all post-RK patient groups [13].

IOL selection should be based on the cornea's optical function and the quality of the cornea using topographic and tomographic data, including the amount of high order aberrations present in addition to the patient's glare/halos intolerance since that has an additional consideration when EDOF or multifocal IOLs are being used. The adjustable intraocular lenses like LAL may also help with reducing the uncertainty associated with preoperative refractive predictions in patients that have undergone previous refractive procedures. [8-9]

Corneal imaging and eligibility for toric or presbyopia-correcting IOLs. Corneal topography and tomography assist to evaluate the degree of corneal regularity, assess whether an ablation was centered, and exclude ectatic diseases as well as other abnormalities. [2,15] A stable axis with symmetrical astigmatism supports the consideration of toric intraocular lenses (IOLs). In contrast, asymmetric, irregular astigmatism, or suspicious tomographic values indicate a need for monofocal IOLs and a more conservative approach. A comprehensive review highlighted the need of utilizing corneal imaging patterns to determine eligibility for toric and presbyopia-correcting optics, as well as to integrate prospective enhancement planning into the preoperative approach [15].

Target refraction and patient counseling. Refractive target in patients after laser eye surgery should be customized to reduce the dissatisfaction seen with hyperopia surprise and uncorrected refractive errors due to an incorrect estimation of corneal powers. In patients that have had radial keratotomy (RK), it is particularly important to use conservative targets as well as clearly communicate the greater variability of the outcome of these patients. [7] Counseling for post refractive surgical patients must include a discussion of the increased likelihood of additional corrective surgeries compared to those who did not undergo refractive surgery; intraocular lens (IOL) choice must also take into account the patient's sensitivity to glare, haloes and decreased contrast. [11,15]

Intraoperative adjuncts and residual refractive error management. The use of intra-operative aberrometry can be beneficial in selected complex cataract surgery cases. Nevertheless, meta-analytical reviews have shown that intraoperative aberrometry will not replace all the required care to perform accurate biometric measurements and application of sophisticated formulas to predict the postoperative refractive error [10]. Studies further suggest that if an uncorrected refractive error remains after cataract surgery, an individual choice should be taken regarding alternative options for corneal enhancements. These corneal enhancements include; PRK or LASIK or supplementary (piggyback) IOL placement or IOL exchange [11].

Discussion

Recent (2021–2026) PubMed/MEDLINE evidence indicates that cataract surgery after corneal refractive procedures is typically safe, however refractive outcomes are less predictable in operated eyes than in unoperated eyes. The primary sources of potential error are the estimation of corneal power in surgically-altered corneas and its impact on the calculation of the effective lens position (ELP) using most intraocular lens (IOL) formulas, thereby amplifying the potential for postoperative refractive error. [2] The variability is greatest after radial keratotomy (RK) due to both the irregular optics and refractive instability that contribute to reduced predictability. [7,13]

Consistently across studies, the quality of ocular surface disease was identified as a modifiable factor that could potentially affect the accuracy of the preoperative measurements. Ocular surface disease could lead to unstable keratometry readings and potentially change the amount and direction of astigmatism, resulting in clinically significant IOL power errors and toric misalignment. As a result, treatment of ocular surface disease and/or lid disease prior to definitive biometry and re-measuring after stabilization of the tear film is consistently recommended. [1] Additionally, there is growing support for the posterior cornea being incorporated into corneal power assessment. Traditional keratometry is potentially inaccurate in post-ablated myopic eyes since it assumes a consistent relationship between the anterior and posterior cornea, which could result in hyperopic surprise. [2] Swept-source OCT biometers have been shown to measure total keratometry (TK), incorporating posterior curvature, and are recommended as the preferred input source over traditional keratometry in post-refractive eyes. [3]

Even though the chosen calculation strategy utilized can influence results, comparative studies demonstrate that modern "no-history" strategies, particularly those utilizing total keratometry (TK), can produce relatively accurate outcomes in eyes that have undergone post-myopic laser treatments. [4,12,16] The implementation of Barrett True-K within biometers appears to be comparable to multi-formula-based approaches, while providing a simpler decision-making process. A Bayesian network meta-analysis demonstrated that Barrett True-K No-History, OCT-based methods and Masket-type modifications were categorized as some of the

higher performing strategies in cohorts of eyes that had undergone post-myopic laser treatments. [6,14] There is limited evidence related to post-SMILE eyes; however, several case-series have suggested that utilizing a comprehensive corneal model (i.e. ray-tracing) may provide an improvement in accuracy compared to keratometry-based approaches in specific cases. [5]

Corneal imaging provides a method to convert these findings into applicable IOL selection and patient expectation. Topography/tomography can aid in assessing the regularity of the cornea, centrality of the cornea and the risk of ectasia; however, topographic/tomographic patterns of asymmetry/irregularity generally decrease the confidence in the keratometric-based planning and in many cases limits candidacy for toric and presbyopia-correcting optics. [15] Eyes that have undergone RK should be considered as a unique high-variability subgroup, and should be managed conservatively with aggressive targeting and explicit counseling regarding the larger potential outcome range and potential for staged correction. [7,13,14]

Intraoperative aberrometry may assist in certain complicated cases, but does not serve as a replacement for rigorous preoperative measurement and use of the most advanced formula. [10] Should a significant amount of residual refractive error persist following cataract surgery, management options may include corneal laser enhancement, supplemental (piggyback) IOL placement, or IOL exchange. Chosen on a case-by-case basis, adjustable technologies such as the light adjustable lens may also reduce residual refractive error through postoperative adjustment in select patients. [8,9,11] The limitations of the current body of literature include the heterogeneity of types of refractive surgery, incomplete historical information, definitions of corneal power across devices, and lack of uniformity in reporting of outcomes. Therefore, development of standard endpoints and more rigorous stratification is necessary specifically in post-RK cohorts. [13,14]

Sequential conclusions

1. The risk of refractive surprise increases with corneal refractive surgery as there are violations of the assumption about corneal power and ELP (effective lens position) in standard models.

2. Optimization of the ocular surface before taking the last measurements for final biometry is a critical step that has a positive impact on the reliability of these measurements.

3. Evaluation that takes into account the posterior portion of the cornea (total keratometry), can better characterize the power of the cornea and therefore improve accuracy in certain patient populations.

4. Barrett True-K offers high-quality performance without history information and it also reduces the complexity of the clinical process.

5. Post-RK patients represent the least reliable subgroup in terms of predictability; all surgeons should therefore apply a conservative approach to target selection and provide explicit counseling.

6. Using adjustable IOLs and providing an individualized enhancement pathway for patients who experience residual errors can increase patient satisfaction.

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KATARAKTOS OPERACIJA PO RAGENOS REFRAKCINĖS CHIRURGIJOS: ĮRODYMAI IR LITERATŪROS APŽVALGA

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Raktažodžiai: kataraktos operacija, ragenos refrakcinė chirurgija, LASIK, PRK, SMILE, radialinė keratotomija, intraokulinis lęšis, IOL galios apskaičiavimas, bendroji keratometrija, Barrett True-K, šviesos reguliuojamas lęšis, intraoperacinė aberometrija.

Santrauka

Tikslas. Šioje literatūros apžvalgoje (2021–2026 m.) siekiama išnagrinėti PubMed/MEDLINE duomenis apie kataraktos operaciją po ragenos refrakcinės chirurgijos ir įtraukti biometrinių duomenų vertinimą, IOL galios apskaičiavimą, IOL pasirinkimą ir kitų refrakcijos klaidų valdymą.

Metodai. Struktūrizuota PubMed/MEDLINE paieška buvo atlikta naudojant MeSH ir laisvos formos terminus, susijusius su kataraktos operacija po LASIK / PRK / SMILE, radialine keratotomija, įskaitant IOL galios apskaičiavimus, Barrett True-K, bendrąją keratometriją, intraoperacinę aberometriją ir šviesos reguliuojamus lęšius. Tinkami leidiniai (2021–2026 m.) apėmė suaugusiųjų tyrimus, lyginamuosius tyrimus, sistemines apžvalgas / metaanalizes, technologijų vertinimus ir klinikinius apžvalginius straipsnius.

Rezultatai. Refrakcijos nuspėjamumas po kataraktos operacijos yra mažesnis akims po refrakcinės operacijos nei akims su negydytomis ragenomis dėl netikslių ragenos galios matavimų ir veiksmingos lęšiuko padėties įvertinimo. Matavimo kokybė (sutelkiant dėmesį į akių paviršiaus būklės optimizavimą) ir užpakalinės ragenos galios naudojimas (bendroji keratometrija, jei įmanoma) pagerins įvesties duomenis. Biometruose įdiegti Barrett True-K algoritmai veikia nuosekliai po LASIK / PRK operacijų, tačiau po radialinės keratotomijos akys išlieka nenuspėjamos. Pacientams, kuriems atliekamos papildomos ir (arba) korekcinės intervencijos (pavyzdžiui, LAL, ragenos korekcijos arba antrinės IOL), gali sumažėti likusios refrakcijos klaidos. Išvada. Kataraktos operacija po ragenos refrakcinės chirurgijos paprastai laikoma saugia, tačiau reikalauja kruopštaus pasirengimo prieš operaciją. Optimali praktika apima modernų ragenos galios apskaičiavimą, IOL apskaičiavimą be anamnezės ir aiškų konsultavimą apie refrakcijos neapibrėžtumą, ypač po RK.

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