Corneal Higher-Order Aberration Induction After PRK Versus LASIK for Myopic Correction: A Systematic Review and Meta-Analysis

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INTRODUCTION

- Myopia is highly prevalent globally, and **PRK and LASIK** remain widely used excimer laser procedures for myopic correction.[1]
- Although both procedures reshape the cornea, they differ structurally: PRK uses surface ablation, whereas LASIK requires flap creation and stromal ablation beneath the flap.[2]
- Corneal higher-order aberrations (HOAs), including total **HOA RMS**, **spherical aberration**, and **coma**, reflect optical changes at the tissue directly remodeled by laser ablation.[3]
- Comparative studies of PRK and LASIK have reported inconsistent corneal HOA findings, likely due to differences in **ablation profile, laser platform**, measurement method, and follow-up duration.[4]
- A **corneal-specific synthesis** is needed to clarify whether PRK and LASIK are optically equivalent at the corneal plane.

AIM

To quantify and compare **induced corneal HOAs** after PRK versus LASIK for myopic correction, focusing on total corneal HOA RMS, corneal spherical aberration, corneal coma, ablation profile, and laser platform.

METHODS

- Six databases searched to Sept. 2, 2025, for **comparative adult PRK vs LASIK** studies reporting **corneal HOA** outcomes.
- Mean differences were pooled using random-effects meta-analysis.
- Subgroup analyses examined ablation profile and excimer laser platform.
- Risk of bias/certainty: ROBINS-I and GRADE.

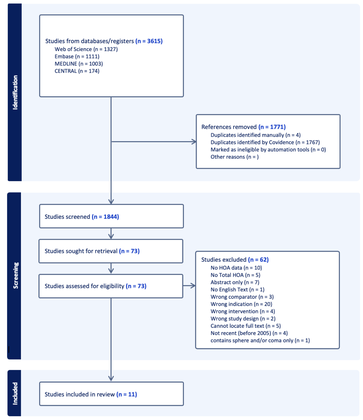

Figure 1. Study selection outlining citations identified, screened, reviewed, and included.

RESULTS

Study	Design	Country	Group	n (eyes)	Baseline SE (D)	Ablation profile	Aberrometry	Excimer platform	Flap creation
AlMahmoud 2011	Retrospective single-centre analysis	Canada	LASIK (Epi-LASIK)	60	−4.02 ± 1.93	Wavefront-guided (Fourier)	Pentacam (ACAP)	VISX STAR S4 IR	Epithelial flap (Gebauer/ethanol)
			PRK	60	−3.98 ± 2.01	Wavefront-guided (Fourier)	Pentacam (ACAP)	VISX STAR S4 IR	—
Miraftab 2021 (moderate)	Prospective matched cohort	Iran	Femto-LASIK	124	−4.47 ± 0.82	Wavefront-optimized	Sirius	WaveLight EX500	Femtosecond (Femto LDV, 110 µm)
			PRK	124	−4.36 ± 0.72	Wavefront-optimized	Sirius	WaveLight EX500	—
Moshirfar 2024	Retrospective chart review	USA	LASIK	154	−3.51 ± 0.22	Wavefront-optimized	Pentacam HR	WaveLight EX500	Femtosecond (FS200, 100 µm)
			PRK	173	−3.81 ± 0.16	Wavefront-optimized	Pentacam HR	WaveLight EX500	—
Reed 2017 (EX500)	Retrospective analysis	USA	LASIK	22	−4.38	Wavefront-optimized	Pentacam (Scheimpflug)	WaveLight EX500	Femtosecond
			PRK	96	−3.35	Wavefront-optimized	Pentacam (Scheimpflug)	WaveLight EX500	—
Reed 2017 (VISX)	Retrospective analysis	USA	LASIK	22	−2.73	Wavefront-guided (CustomVue)	Pentacam (Scheimpflug)	VISX STAR S4 IR	Femtosecond
			PRK	100	−3.33	Wavefront-guided (CustomVue)	Pentacam (Scheimpflug)	VISX STAR S4 IR	—
Wu 2021	Prospective comparative	China	FS-LASIK	88	−4.27 ± 1.02	Aspheric/aberration-free (ORK-CAM)	Pentacam	Schwind AMARIS 1050	Femtosecond (IntraLase, 95–110 µm)
			Trans-PRK	64	−4.06 ± 1.09	Aspheric/aberration-free (ORK-CAM, SPT)	Pentacam	Schwind AMARIS 1050	—
Xu 2025	Prospective cohort	China	FS-LASIK	100	−4.47 ± 1.39	SmartPulse non-spherical	Pentacam (6 mm)	Schwind AMARIS 1050	Femtosecond (IntraLase, 95–110 µm)
			Trans-PRK	90	−3.54 ± 1.25	SmartPulse non-spherical	Pentacam (6 mm)	Schwind AMARIS 1050	—
Yang 2023	Prospective comparison	China	FS-LASIK	42	−6.00 ± 2.11	Aspheric (AMARIS 1050S)	Pentacam HR (6 mm)	Schwind AMARIS 1050S	Femtosecond (VisuMax, 110 µm)
			Trans-PRK	48	−5.61 ± 1.71	Aspheric single-step t-PRK	Pentacam HR (6 mm)	Schwind AMARIS 1050S	—
Zhang 2020	Prospective comparative	China	FS-LASIK	56	−4.79 ± 1.15	Aspheric/aberration-free (SmartPulse)	Pentacam	Schwind AMARIS 750s	Femtosecond (VisuMax, 105–110 µm)
			Trans-PRK	56	−4.71 ± 1.04	Aspheric/aberration-free (SmartPulse)	Pentacam	Schwind AMARIS 750s	—
Wu 2022	Prospective comparative	China	FS-LASIK	77	SEQ −5.23 ± 1.35	Aberration-free	Pentacam (posterior)	Schwind AMARIS 1050	Femtosecond (Ziemer, 95–110 µm)
			Trans-PRK	65	SEQ −5.07 ± 1.73	Aberration-free single-step t-PRK	Pentacam (posterior)	Schwind AMARIS 1050	—
Russo 2021 (myopic)	Retrospective comparative	Italy	LASIK (regular/WFG)	304 / 106	−4.84 ± 2.07 / −4.94 ± 2.22	Regular or wavefront-guided	Pentacam-AXL (6 mm)	VISX STAR S4 IR	Femtosecond (IntraLase FS 150 kHz, 100 µm)
			PRK (regular/WFG)	44 / 30	−4.14 ± 1.60 / −4.18 ± 1.95	Regular or wavefront-guided	Pentacam-AXL (6 mm)	VISX STAR S4 IR	—

Table 1. Characteristics of included comparative studies.
Summary of study design, country, treatment groups, sample size, baseline spherical equivalent, ablation profile, corneal aberrometry system, excimer platform, and LASIK flap-creation method.

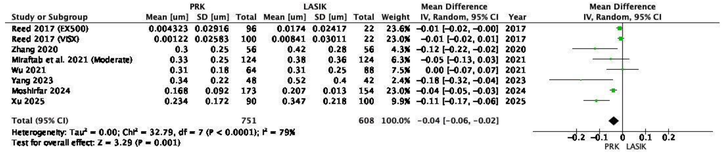

Figure 2. Total corneal HOA RMS: overall analysis
Forest plot comparing induced total corneal higher-order aberration RMS after PRK versus LASIK at longest follow-up. Negative mean differences favour PRK.

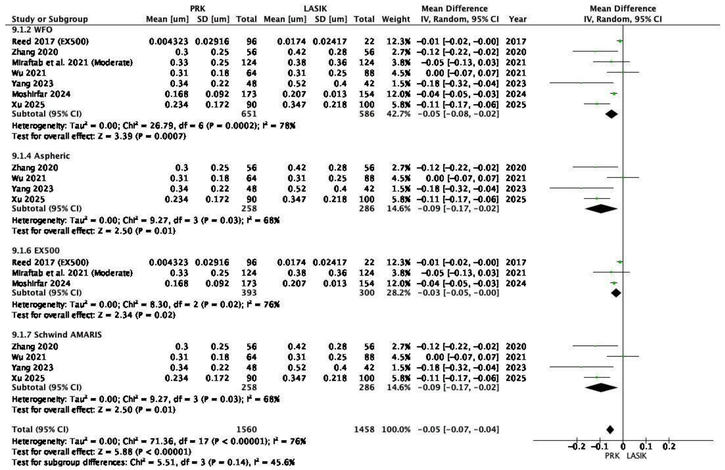

Figure 3. Total corneal HOA RMS by ablation profile and laser platform
Subgroup forest plot of induced total corneal HOA RMS stratified by ablation profile and excimer laser platform. PRK showed lower induced corneal HOA RMS across most subgroups.

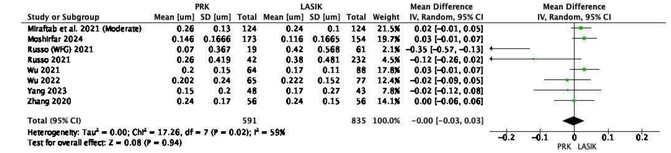

Figure 4. Corneal spherical aberration: overall analysis
Forest plot comparing induced corneal spherical aberration after PRK versus LASIK at longest follow-up. The pooled estimate showed no significant overall difference.

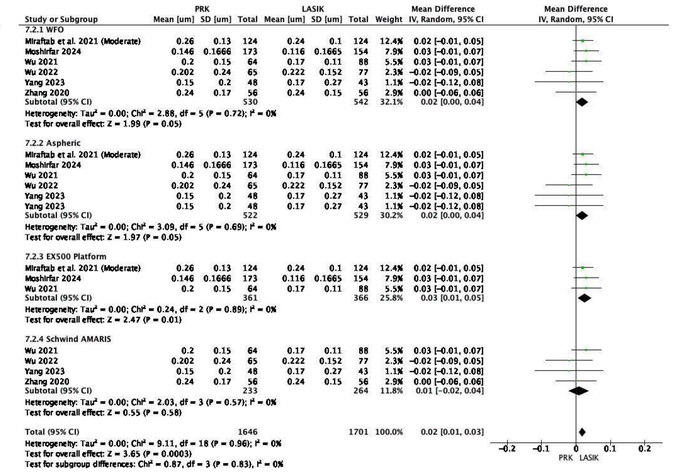

Figure 5. Corneal spherical aberration sensitivity and subgroup analysis
Sensitivity and subgroup forest plot for induced corneal spherical aberration after excluding outlying Russo 2021 data. The pooled estimate showed a small LASIK-favouring effect with reduced heterogeneity.

RESULTS–KEY POINTS

- Ten comparative studies met inclusion criteria; eight contributed to the pooled total corneal HOA RMS analysis.
- PRK induced fewer total corneal HOAs than LASIK overall: **MD −0.04 µm, 95% CI −0.06 to −0.02; I² = 79%.**
- The PRK-favouring effect persisted in wavefront-optimized procedures: **MD −0.05 µm, 95% CI −0.08 to −0.02.**
- Aspheric/aberration-free profiles also favoured PRK: **MD −0.09 µm, 95% CI −0.17 to −0.02.**
- Corneal spherical aberration did not differ overall: **MD 0.00 µm, 95% CI −0.03 to 0.03.**
- After excluding outlying Russo 2021 data, spherical aberration showed a small LASIK-favouring effect: **MD 0.02 µm, 95% CI 0.00 to 0.04; I² = 0%.**
- Corneal coma findings were less suitable for pooling, but vertical coma tended to increase more after LASIK.

CONCLUSION

- PRK and LASIK are **not optically interchangeable** at the corneal plane.
- PRK induced slightly fewer **total corneal HOAs** than LASIK, particularly in **wavefront-optimized** and **aspheric/aberration-free** ablation profiles.
- Corneal spherical aberration was broadly similar between procedures, with sensitivity analysis suggesting a **small LASIK-favouring effect** after excluding outlying data.
- Procedure selection should consider **ablation profile, excimer platform**, and **patient-specific visual priorities** rather than assuming equivalent corneal optical outcomes.

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