Огляд літератури

Efficacy and Safety Profile of Laser-Assisted In-Situ Keratomileusis and Photorefractive Keratectomy for Myopia Correction: A Systematic Review and Meta-Analysis

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Профіль ефективності та безпеки лазерного кератомілезу in-situ та фоторефракційної кератектомії для корекції міопії: систематичний огляд та мета-аналіз

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Abstract

Introduction. *Myopia is one of the important causes of visual impairment worldwide. The two most common refractive surgeries for myopia treatment are LASIK (Laser-Assisted In-Situ Keratomileusis) and PRK (Photorefractive Keratectomy).*

Purpose. *This study investigates the efficacy and safety of LASIK and PRK for Myopia correction.*

Methods. *A systematic review was conducted following PRISMA 2020 guidelines across PubMed, Cochrane, and ScienceDirect databases through December 2024. The quality and bias of studies were assessed using the assessment tool developed by the Effective Public Health Practice Project. The data were summarized using odds ratios (OR) with 95% confidence intervals (CI) and mean differences to determine the efficacy and safety of LASIK and PRK for myopia.*

Result. *Nine randomized controlled trial studies from 1998 to 2014 were included, involving 698 eyes with any degree of myopia. The meta-analysis found no significant difference in the proportion of eyes achieving uncorrected visual acuity of 20/20 at 6 months (pooled OR, 0.84; 95% CI, 0.53-1.34; P = 0.47) and 12 months (pooled OR, 1.11; 95% CI, 0.62-2.01; P = 0.72). LASIK and PRK were equally effective for the proportion of eyes achieving within ± 0.50 D of target refraction at 12 months (OR, 1.00; 95% CI, 0.40–2.51; P = 1.00). Loss of 2 lines of best corrected visual acuity at 6 months was less frequent with LASIK (OR, 2.41; 95% CI, 0.73-7.18; P = 0.15). It was found that both LASIK and PRK interventions did not have a significant difference in postoperative mean spherical equivalent until 1 year of follow-up (0.07; 95% CI, 0.05-0.19; I2 = 16%).*

Conclusions. *Efficacy, safety and visual outcomes of LASIK for myopia are similar to those achieved with PRK.*

Keywords. *Laser in situ keratomileusis (LASIK); Meta-analysis; Myopia; Photorefractive Keratectomy (PRK)*

DOI: https://doi.org/10.31288/Ukr.j.ophthalmol.202625765

UDC: 617.753.2-089-085.849.19

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Received 2025-10-30
Accepted 2026-03-14

Cite this article as: Irfan Bari Cahyoputra, Aqila Fathimah Putri. Efficacy and Safety Profile of Laser-Assisted In-Situ Keratomileusis and Photorefractive Keratectomy for Myopia Correction: A Systematic Review and Meta-Analysis. Ukr J Ophthalmol. 2026;1:57-65.

Резюме

Вступ. *Міопія є однією з значних причин порушення зору в усьому світі. Двома найпоширенішими рефракційними операціями для лікування міопії є LASIK (лазерний кератомілез in-situ) та PRK (фоторефрактивна кератектомія).*

Мета. *Вивчити ефективність та безпеку LASIK й PRK для корекції міопії.*

Методи. *Систематичний огляд було проведено в базах даних PubMed, Cochrane та ScienceDirect до грудня 2024 року відповідно до рекомендацій PRISMA 2020. Проект «Ефективна практика громадського здоров'я»*

(EPHPP) оцінив якість дослідження та упередженість. Ми узагальнили дані, використовуючи відношення шансів (ВШ) з 95% довірчими інтервалами (ДІ) та середніми відмінностями, щоб розрахувати ефективність та безпеку LASIK та PRK для лікування міопії.

Результат. *Було включено дев'ять рандомізованих контрольованих досліджень з 1998 по 2014 рік, що охопили 698 очей з міопією будь-якого ступеня. Результати метааналізу вказують на те, що не було суттєвої різниці у пацієнтів, які досягли некоригованої гостроти зору 20/20 через 6 місяців (об'єднаний OR 0,84; 95% ДІ 0,53–1,34); (p=0,47) та 12 місяців (об'єднаний OR 1,11; 95% ДІ 0,62–2,01); (p=0,72). LASIK та PRK однаково ефективні у досягненні цільової рефракції ± 0,50 D через 12 місяців (OR 1,00; 95% ДІ 0,40–2,51); (P=1,00). Зменшення найкраще коригованої гостроти зору на 2 лінії через 6 місяців зустрічалася рідше при LASIK (OR 2,41; 95% ДІ 0,73–7,18); (P=0,15). Було виявлено, що як втручання LASIK, так і PRK не мали суттєвої різниці в середній післяопераційній самооцінці (SE) до 1 року спостереження (0,07; 95% ДІ -0,05 - 0,19; I2 = 16%).*

Висновки. *LASIK та PRK продемонстрували однакову ефективність та безпеку щодо зору при лікуванні міопії.*

Ключові слова. *Лазерний кератомілез in situ (LASIK); Мета-аналіз; Міопія; Фоторефракційна кератектомія (PRK).*

Introduction

Myopia is the leading cause of vision impairment worldwide. In 2020, an estimated 2.62 billion people globally were affected by myopia, impacting quality of life and productivity [1, 2] . Based on the diopter (D), myopia can be divided into three levels: low myopia (0.00 to -3.00 D), moderate myopia (-3.00 to -6.00 D), and high myopia (over -6.00 D) [3]. Refractive surgery offers a potential curative approach for refractive errors providing an alternative to lifelong reliance on contact lenses or glasses [4]. The two most common surgical techniques to correct myopia are photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK) [5].

PRK represents the first generation of excimer laser refractive surgery and was approved by the US Food and Drug Administration (FDA) in 1996. In PRK, the corneal epithelium is mechanically removed, and the anterior stromal lamellae are precisely reshaped using excimer laser ablation [5, 6]. Postoperative complications may include pain, corneal haze, and irregular epithelial healing [6]. Mitomycin-C (MMC), an antimetabolite that can block DNA and RNA replication and inhibit protein synthesis, is used as an adjunct to prevent post-PRK corneal haze, especially in high myopia [5, 7]. Despite these limitations, PRK remains the preferred option for patients unsuitable for LASIK, including those with thin corneas, irregular corneal surfaces, pre-existing corneal pathology, or a high risk of ocular trauma [6].

Following the development of PRK, LASIK emerged as a significant advancement in excimer laser refractive surgery.[[3]]LASIK, approved by the FDA in 1998, became the most popular refractive technique in the late 1990s due to lesser postoperative discomfort, faster recovery of vision, and reduced haze. LASIK rapidly became the preferred procedure. In LASIK, a microkeratome or a femtosecond laser creates a hinged corneal flap. This flap is then gently lifted, the underlying corneal tissue is reshaped with the laser, and finally, the flap is carefully repositioned over the treated area. While LASIK offers significant advantages, it is associated with unique risks, including flap-related complications, altered corneal biomechanics, and an increased risk of postoperative ectasia due to reduced residual stromal thickness [5, 8, 9].

PRK and LASIK utilize excimer lasers to reshape the cornea and correct refractive errors by removing corneal tissue. The popularity of these procedures has surged over the past two decades. The most concerning outcome for both is the loss of best-corrected vision. Preoperative screening for risk factors like high myopia, early signs of keratoconus, and insufficient residual corneal thickness is crucial to minimize complications. Given the increasing number of individuals undergoing refractive surgery and the expanding use of advanced laser platforms, an up-to-date synthesis of comparative evidence is clinically and scientifically necessary.

Aim. This systematic review and meta-analysis aims to clarify whether meaningful differences exist between these procedures across short- and long-term follow-up, thereby supporting optimized procedure selection in contemporary refractive practice.

Methods

Eligibility Criteria

We included trials in which the participants were men and women over 18 years of age undergoing LASIK or PRK for myopia or myopic astigmatism. Eligible studies were required to report postoperative visual or refractive outcomes with a minimum follow-up duration of 6 months. People undergoing treatment for correction of refractive errors other than primary myopia were excluded, as were those with any other co-existing ocular or systemic disease.

Information sources

Using the PRISMA guidelines, the current systematic review employed a concept-by-concept approach to retrieve all relevant scholarly articles from PubMed, Cochrane, and ScienceDirect databases. We searched the databases for all English language publications through December 2024 meeting search criteria, with the article type restricted to clinical trials.No restrictions were placed on geographical location or surgical platform used.

Search Strategy

The search string was: ("LASIK" OR "Laser-Assisted In Situ Keratomileusis" OR "Laser Intrastromal Keratomileusis" OR "Laser In Situ Keratomileusis" OR "Laser Intrastromal Keratomileusis" OR "Laser-

Assisted Stromal In Situ Keratomileusis") AND ("PRK" OR "Photorefractive Keratectomy" OR "Keratectomies, Photorefractive" OR "Keratectomy, Photorefractive" OR "Photorefractive Keratectomies") AND ("Ophthalmologic Surgical Procedures" OR "Refractive Surgical Procedures" OR "Corneal Laser Surgery") AND ("Myopia" OR "Nearsightedness" OR "Nearsightednesses").

Outcome types and measures

Efficacy measures included uncorrected visual acuity (UCVA) of 20/20 or better at 6 and 12 months post-treatment, the proportion of eyes within ± 0.50 D of target refraction at 6 and 12 months post-treatment, and mean postoperative spherical equivalent (SE) at 2-4 weeks, 6 months and 12 months. Safety measures included the proportion of eyes within ± 0.50 D of target refraction at 12 months post-treatment. Adverse effects included pain scores, subepithelial haze, flap-related complications in LASIK eyes, optical side effects, high-order aberration, and refractive stability. Patient satisfaction questionnaires were used 1 year and 2 years after surgery to assess patient satisfaction.

Data extraction

Two reviewers independently did the primary screening in Rayyan (an AI-powered tool for Systematic Literature Reviews) based on the inclusion criteria previously mentioned, and disagreements were settled by discussion. We extracted demographic data, methodological characteristics, characteristics of the subjects, and outcomes data. All the data were entered into Excel before conducting further data analysis using Revman Manager..

Quality assessment

The risk of bias of the included studies was assessed with the Effective Public Health Practice Project (EPHPP). The following six domains were assessed: selection bias, study design, confounders, blinding, data collection methods, and withdrawal and dropout. An overall quality score was assigned to each study. Two reviewers perform this process independently, and any disagreements were managed by discussion.

Statistical analysis

The systematic review and meta-analysis were conducted in accordance with Cochrane Collaboration recommendations and PRISMA guidelines. Data were entered into Review Manager (RevMan) software by one author and independently verified by a second author. For studies in which numerical outcome data were presented only graphically, values were extracted using a web-based plot digitizer. Pooled analyses were performed using a random-effects model; however, a fixed-effect model was applied when fewer than three studies were available or when event rates were low. Odds ratios were calculated for dichotomous outcomes, and mean differences were used for continuous outcomes. Statistical heterogeneity was assessed visually using forest plots and quantitatively using the I^2 statistic, with $I^2 \geq 50\%$ indicating substantial heterogeneity.

Results

Nine studies comparing LASIK and PRK for myopia and published from 1998 to 2014 were included (Figure 1). The figure shows a PRISMA flow chart summarizing the results of the search and the reasons for exclusion. This review included only randomized controlled trials (RCTs; 698 eyes, Table 1), with ages ranging from 18 to 64 years. Myopia ranged from -0.5 D to -15.0 D. However, Barreto et al. (2010) did not mention the range. The duration of follow-up of the studies varied from 1 month to a maximum of 2 years, with a study by El Maghraby et al. demonstrating the longest follow-up. Efficacy and safety outcome measures were used in all, and adverse effect measures were employed in the majority of included studies. The study by El Maghraby et al. was the only study that employed a patient satisfaction outcome measure.

Quality Assessment

Of the nine RCTs comparing LASIK and PRK (Table 2), three received moderate quality score ratings [10–12] and six strong score ratings [13–18]. All included studies were at a low risk of selection bias, indicating that they had clear randomization. Additionally, all included studies were designed as RCT studies. The studies were randomized, specified exact interventions that patients had received, and each study was at low risk for the cofounder. Low ratings were mainly attributable to the likelihood of blinding bias; 3 studies were assessed to be at high risk, and 1 study was at moderate risk for blinding bias; these studies did not explain clearly whether there was blinding of the subjects or blinding of examiners. Each study also provided an overview of data collection using proper tools tested for validity and reliability. The missing numbers of withdrawals and dropouts have also been explained clearly in each study.

The proportion of participants who have UCVA 20/20 or better at 6 months and 12 months after treatment is shown in Fig. 2 and Fig. 3. The forest plot analysis demonstrated no significant difference between LASIK and PRK for key efficacy outcomes, including the proportion of patients achieving uncorrected visual acuity (UCVA) of 20/20 or better at both 6 months and 12 months. For UCVA at 6 months, the pooled odds ratio (OR) was 0.84 (95% CI, 0.53-1.34; p = 0.47), and at 12 months, the OR was 1.11 (95% CI, 0.62-2.01; p = 0.72).

The proportions of participants achieving UCVA of 20/20 or better at 6 months and 12 months after treatment are shown in Figures 2 and 3. The forest plot analysis demonstrated no significant difference between LASIK and PRK for key efficacy outcomes, including the proportions of patients achieving UCVA of 20/20 or better at 6 months and 12 months. For UCVA at 6 months, the pooled odds ratio (OR) was 0.84 (95% CI, 0.53-1.34; p = 0.47), and at 12 months, the OR was 1.11 (95% CI, 0.62-2.01; p = 0.72). The proportions of participants within ± 0.50 D of target refraction at 6 months and 12 months after treatment are shown in Figures 4 and 5. LASIK and PRK showed similar results in achieving within ±0.50 diopters of target refraction at 6 months (OR, 1.05; p = 0.81) and

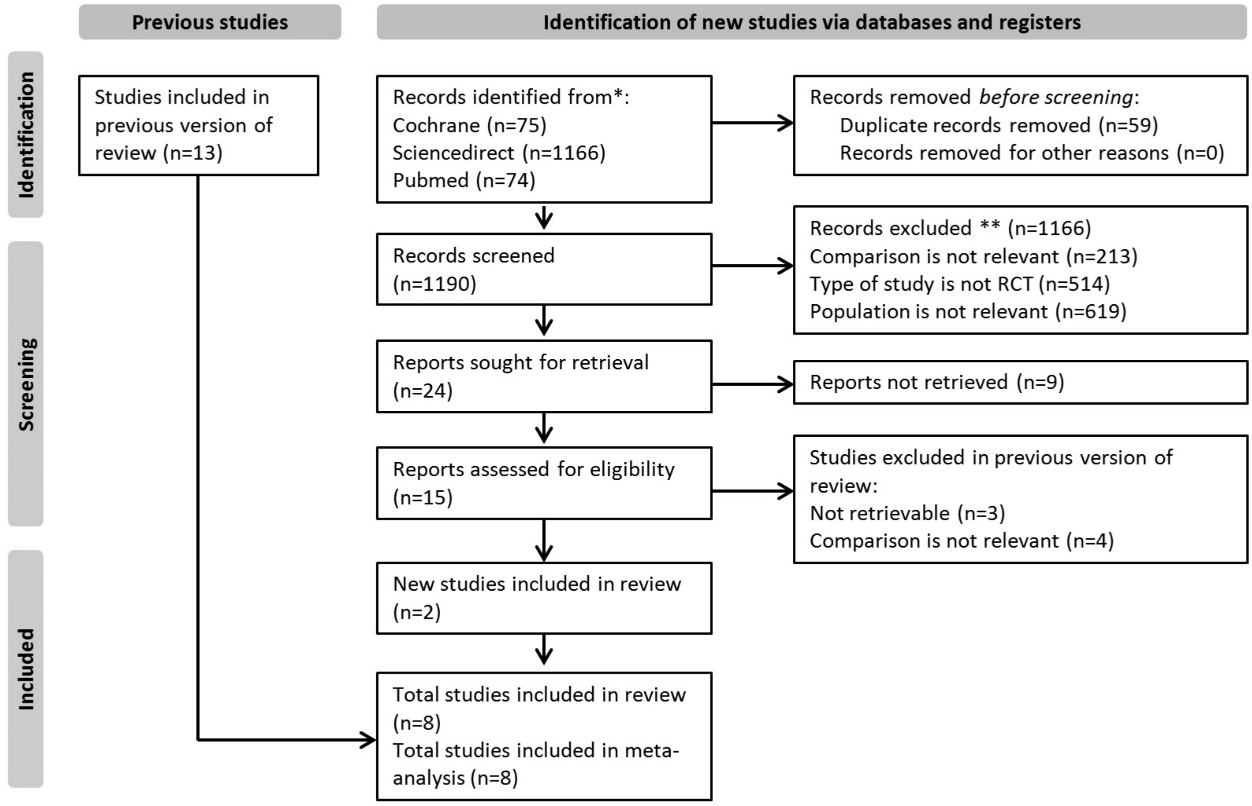

Figure 1. Articles included in this study selected with PRISMA Guideline.

Abbreviations: PRISMA - Preferred Reporting Items for Systematic Reviews and M eta-Analyses.

	PRK		LASIK			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
el magriby 1999	12	29	19	28	29.6%	0.33 [0.11, 0.99]
hatch 2011	24	26	23	26	4.6%	1.57 [0.24, 10.24]
Hersh 1998	13	68	16	61	35.7%	0.66 [0.29, 1.53]
Lee 2001	35	45	28	45	16.3%	2.13 [0.84, 5.36]
Manche 2011	27	33	29	33	13.8%	0.62 [0.16, 2.44]
Total (95% CI)		201		193	100.0%	0.84 [0.53, 1.34]
Total events	111		115			

Heterogeneity: $Chi^2 = 7.55$, df = 4 (P = 0.11); $I^2 = 47\%$
Test for overall effect: Z = 0.73 (P = 0.47)

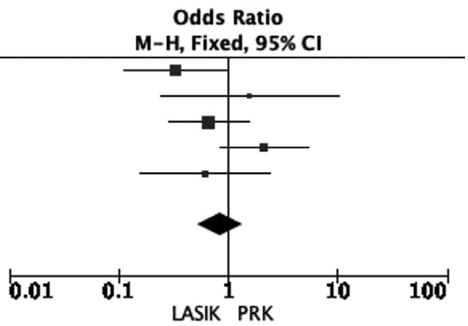

Figure 2. UCVA 20/20 or Better after 6 months of follow-up. Abbreviations: PRK – photorefractive keratectomy; LAS1K – laser-assisted in situ keratomileusis; UCVA – uncorrected visual acuity; OR – odds ratio; CI – confidence interval; M-H – Mantel Haenszel method; df – degrees of freedom; Chi ^{2} – Chi-squarc test; I ^{2} – heterogeneity statistic.

	PRK		LASIK			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M-H, Fixed, 95% CI
el magriby 1999	16	29	20	28	43.7%	0.49 [0.16, 1.48]
Manche 2011	27	33	29	33	25.2%	0.62 [0.16, 2.44]
Wallau 2008	22	44	13	44	31.1%	2.38 [0.99, 5.73]
Total (95% CI)		106		105	100.0%	1.11 [0.62, 2.01]
Total events	65		62			

Heterogeneity: $Chi^2 = 5.72$, df = 2 (P = 0.06); $I^2 = 65\%$
Test for overall effect: Z = 0.36 (P = 0.72)

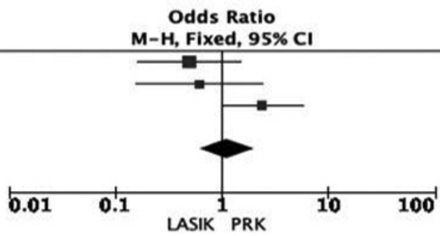

Figure 2. UCVA 20/20 or Better after 12 months of follow-up. Abbreviations: PRK – photorefractive keratectomy; LASIK – laser-assisted in situ keratomileusis; UCVA – uncorrected visual acuity; OR – odds ratio; CI – confidence interval; M-H – Mantel-Haenszel method; df – degrees of freedom; Chi ^{2} – Chi-squarc test; I ^{2} – heterogeneity statistic.

Table 1. Characteristics of Included Studies

Author, Year, and Study Design	Age	Sex M/F	Number of Eyes and Intervention	Myopia range	Follow up	Outcome	Additional outcome
El Maghraby et al. (1999) RCT	(16- 59) years mean 26.2 ± 9.3	22/11	30 PRK 30 LASIK	-2.50 to -8.00	1-2 years	UCVA better or equal to 20/20, Within 0.05 D of target refraction, Mean spherical equivalent (Efficacy), Loss 1+ line BCVA, Loss 2+ lines BCVA, Final BCVA < 20/40 (Safety)	1. Adverse effect 2. Pain Scores 3. Refractive stability
Barreto et al. (2010) RCT	(25 - 39) years mean age: 33.8 ± 4.8	6/5	11 PRK 11 LASIK	Not stated	3,6,12 months	Efficacy Safety	1. Adverse Effect
Hatch et al. (2011) RCT	(23–46) mean age 30.8 years	13/13	25 PRK 25 thin flap LASIK	-1.5 to –8.5	1,3,6 months	Efficacy Safety	1. Adverse Effect 2. Refractive Stability
Manche et al. (2011) RCT	(26 - 52) mean age 39 ± 7.3 years	15/19	WFG LASIK: 17 WFG PRK 71	0.75 to -8.13	1,3,6,12 months	Efficacy Safety	1. Adverse Effect 2. Refractive Stability
Hersh et al. (2000) and (1998) RCT	PRK : (21–58) mean 39 years LASIK: (21–64) mean 38 years	PRK group: 56/49 LASIK group: 48/67	PRK : 105 LASIK: 115	-6.00 to -15.0	6 months	Efficacy Safety	1. Adverse Effect 2. Refractive Stability
Wallau et al. (2008) RCT	(21 - 54) mean age 31.7 years	18/26	WF LASIK: 44 PRK + mitomycin C: 44	-1.46 to -6.96	1,3,6,12 months	Efficacy Safety	1. Adverse effect 2. Pain Scores 3. Refractive stability
Lee et al. (2001) RCT	N/A	NA	PRK : 45 LASIK: 45	-1.50 to -6.00	1,3,6 months	UCVA better or equal to 20/20, Within 0.05 D of target refraction	1. Adverse Effect
Arora et al. (2014) RCT	Range and mean age WF-LASIK: (20–32 years) 23.4 years WF-PRK: (21–27 years) 22.75 years	NA	WF-LASIK:40 WF-PRK:40	-0.50 to -7.50	1,3,6 months	Mean UCVA, lost ≥2 of CDVA, The number of eyes within ±0.50 D	1. Adverse Effect

Abbreviations: RCT – randomized controlled trial; M/F – male / female; PRK – photorefractive keratectomy; LASIK – laser-assisted in situ keratomileusis; WF/WFG – wavefront-guided; UCVA – uncorrected visual acuity; BCVA – best-corrected visual acuity; CDVA – corrected distance visual acuity; SE – Spherical equivalent; D – diopters; MMC – mitomycin C; N/A – not available.

Table 2. Quality Assesment of Included Studies

Study (Year)	Selection bias	Study design	Cofounders	Blinding	Data collection method	Withdrawal	Overall Quality Score
Manche et al. (2011)	Strong	Strong	Strong	Weak	Strong	Strong	Moderate
Hersh et al. (2000)	Strong	Strong	Strong	Strong	Moderate	Strong	Strong
Hersh et al. (1998)	Strong	Strong	Strong	Strong	Moderate	Strong	Strong
El Maghraby et al. (1999)	Strong	Strong	Strong	Weak	Strong	Strong	Moderate
Wallau et al. (2008)	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Hatch et al. (2011)	Strong	Strong	Strong	Moderate	Strong	Strong	Strong
Barreto et al. (2010)	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Lee et al. (2001)	Strong	Strong	Strong	Weak	Strong	Strong	Moderate
Arora et al. (2014)	Strong	Strong	Strong	Strong	Strong	Strong	Strong

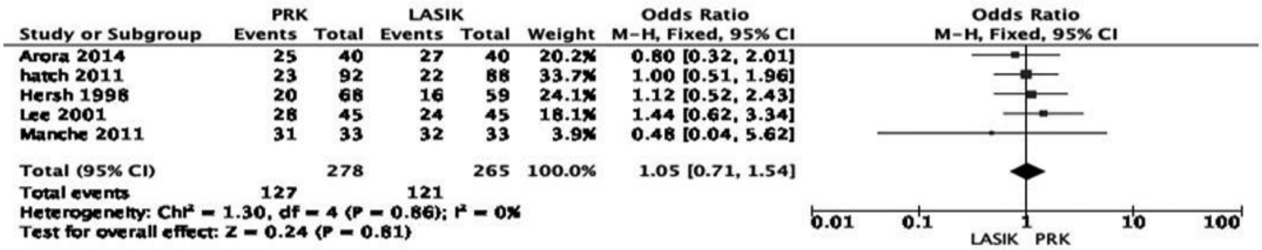

Figure 4. Postoperative Refraction within ±0.50 Diopters of Target Refraction after 6 Months Follow-up. Abbrevatiuns: PRK – photorefractive keratectomy; LASIK – laser-assisted in situ keratomileusis; CI – confidence interval; M-H – Mantel Haenszel method; df – degrees of freedom; OR – odds ratio; I 2 – heterogeneity statistic.

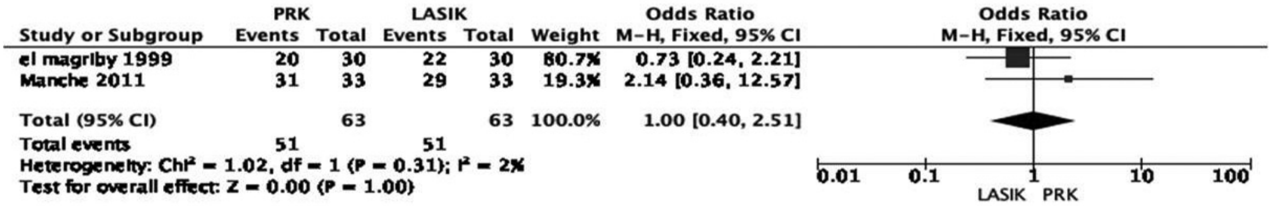

Figure 5. Postoperative Refraction within ±0.50 Diopters of Target Refraction after 12 Months Follow-up. Abbrevutions: PRK – photorefractive keratectomy; LASIK – laser-assisted in situ keratomileusis; CI – confidence interval; M-H: Mantel-Haenszel method; df – degrees of freedom; OR – odds ratio; I^2 – heterogeneity statistic.

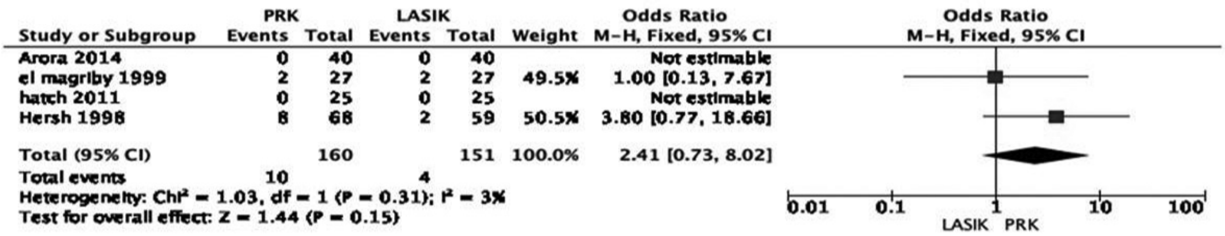

Figure 6. Loss of >2 Lines of Best Spectacle-Corrected Visual Acuity after 6 Months follow up. Abbrevutions: PRK – photorefractive keratectomy; LASIK – laser-assisted in situ keratomileusis; CI – confidence interval; M-H: Mantel-Haenszel method; df – degrees of freedom; OR – odds ratio; I^2 – heterogeneity statistic

12 months (OR, 1.00; p = 1.00). Three RCTs reported data for the proportion of patients losing ≥2 lines at 6 months or more after PRK or LASIK (Figure 6). There was no significant difference in safety outcomes, with both procedures showing similar risk profiles for adverse effects such as the loss of ≥2 lines of best spectacle-corrected visual acuity (BCVA) at 6 months (OR, 2.41; p = 0.15).

Adverse Effect

The analysis of adverse effects revealed that LASIK generally resulted in less postoperative pain than PRK, as assessed by two studies [10,15]. Subepithelial haze was less common after LASIK in several studies.[11–13,16] Four studies reported lower incidence rates at 6 and 12 months [11–13,16]. Flap-related complications in LASIK were found in 2.6% to 15% of cases, but none resulted in a loss of 2 or more lines of BCVA [10,13,16]/ Optical side effects, such as glare and photophobia, were observed after both procedures, although, according to El Maghraby et al. [10], symptoms were more likely to develop after PRK, whereas according to Wallau et al. [15], photophobia was more likely to develop after LASIK than PRK. High-order aberrations were significantly increased in both LASIK and PRK compared with preoperatively [15–18]. Regarding refractive stability, no significant regression was found in either group, although Hersh et al. found a slight change in SE refraction [13]. Patient satisfaction rates at one year were higher with LASIK, and were comparable between LASIK and PRK at 2 years [10]

Discussion

Visual Outcome: Safety and Efficacy

Three trials reported postoperative UCVA of 20/20 or better at 12 months. They did not find evidence supporting the superiority of one intervention over another [10,11,15]. Five trials reported this outcome at six months and found no difference in the proportion of eyes achieving UCVA of 20/20 or better [10–13,16]. Overall, short- to mid-term visual acuity outcomes appear comparable between LASIK and PRK. In contrast to Castro-Luna et al.[9], femtosecond LASIK (FS-LASIK) had better effectiveness than PRK at 3 months, 1 year and 2 years, but at 5 and 10 years, both modalities demonstrated similar efficacy.

Our study demonstrated no significant differences in mean SE and UCVA of 20/20 or better up to one-year follow-up and the loss of >2 lines of BCVA at 6 months. These findings indicate that LASIK provided comparable efficacy and safety to PRK over the first postoperative year. While wavefront-guided (WFG) PRK tended to result in a higher proportion of patients achieving within ± 0.50 D of target refraction at 12 months, this difference was not statistically significant. WFG PRK provided comparable refractive stability to WFG LASIK at 12 months. Li et al. [19] also concluded that the two techniques were similar in effectiveness, safety, refractive predictability, and stability.

Our study demonstrated that LASIK and PRK showed comparable refractive stability, with no significant differences in mean SE until one year of follow-up.However, during the initial 2–4 weeks, PRK exhibited greater refractive instability, whereas LASIK demonstrated faster stabilization. In the studies evaluated, PRK eyes exhibited a higher likelihood of refractive instability in 2–4 weeks, whereas LASIK gave a faster recovery. Only at 2 to 4 weeks post-treatment, the study eyes had a mean SE of more than +- 0.5 D; from this study, it can be concluded that, at 2 to 4 weeks, PRK has a significant chance of refractive instability, and LASIK has a faster recovery in terms of refractive stability. In the first week after PRK, epithelial irregularity often results in reduced visual quality. Tomas et al. [20] found that for target refraction of ± 0.5 dioptres at 6-month and 12-month follow-up, suggesting both treatments were comparable for myopia. In contrast, Mounir et al. [21] found better predictability in FS-LASIK groups of high myopia. Higher variances of SE were observed in Trans-PRK groups during the postoperative 6 months, which might be attributed to the ongoing epithelial healing process. Additionally, a study by Chang et al.[7] found no significant difference between the MMC groups and controls treated for myopia in terms of the predictability of refraction and the proportion of patients with postoperative SE within ± 0.50 D of the target at 12 weeks.

With regard to safety outcomes, our study demonstrated that both modalities had similar safety profiles, as assessed by the loss of >2 lines of BCVA at the 6-month evaluation. Two studies showed that the loss two or more lines of BCVA was more common after PRK, while no studies reported such a loss in LASIK patients [10,13]. These findings suggest a marginal safety advantage for FS-LASIK in early postoperative visual acuity preservation. Our findings align with previous studies, indicating that FS-LASIK has a slightly better safety profile compared to PRK, particularly in terms of visual acuity preservation. The use of femtosecond lasers in LASIK flap creation has improved surgical precision and reduced complications associated with mechanical microkeratomes [7]. Additionally, wavefront-based refractive surgery, including WFG and wavefront-optimized ablation profiles, enables individualized correction of higher-order aberrations (HOAs), which may explain superior optical quality reported with WG-LASIK compared with conventional techniques [19].

Adverse Effect

With regard to the comparison of adverse effects of LASIK versus PRK, LASIK generally results in less postoperative pain; in PRK, the removal of the corneal epithelium is carried out mainly with epithelial mechanical scraping using chemical agents like diluted ethanol solution. The epithelial scraping has postoperative adverse effects like pain, myopia regression, or corneal haze. Exposure to ethanol may increase inflammatory cell infiltration and cause anterior stromal injury, contributing to haze formation [22]. Tomas et al. [20] reported that subepithelial haze occurred in all PRK patients after 1 month, reaching the greatest intensity at 3-6 months. Several studies showed that corneal haze begins to decrease at 12-24 months after PRK and is more common when correcting high myopia (> -6.00 D). Corneal haze tends to be more common after PRK than after LASIK. This is due to damage to the basement membrane and the corneal stromal epithelium, which causes the production of cytokines and growth factors, with these cytokines activating keratocytes and synthesizing collagen fibrils [23]. Corneal haze can affect corneal transparency and reduce visual quality. Numerous ophthalmologists use MMC during surface ablation surgeries to prevent corneal haze formation. [24] MMC is an anti-mitotic agent which inhibits deoxyribonucleic acid synthesis. Ourdane et al. [25] concluded that MMC application after PRK is associated with a lower incidence of corneal haze formation without any statistically significant side effects.

Optical side effects, including glare and photophobia, were more prevalent after LASIK, but both procedures resulted in a statistically significant increase in high-order aberrations. These optical phenomena have been reported in 12–57% of patients following refractive surgery.[26] According to Liu et al.[27], of all PRK patients, 84% had no or mild degree of dry sensation and 16% had significant or severe dry sensation. Keratocyte disturbances, mainly at high frequencies, can reduce contrast sensitivity and cause glare. Van Gelder et al.[28] found that refractive results were relatively stable between 1 and 3-month and 1-year time points after LASIK procedures, whereas myopic regression was observed after PRK. Zhang et al.[29] , however, found that, between 1-month and 12-month follow-up, the proportions of eyes with more than 0.5 D change in SE refraction were 12% and 18% in PRK and LASIK groups, respectively. Overall, both LASIK and PRK demonstrated comparable long-term refractive stability with small fluctuations in spherical equivalent. Hashmani et al.[30] found high patient satisfaction rates after FS-LASIK and after PRK (93.3% versus 95.6%).

This systematic review and meta-analysis have several limitations. There was variability in population characteristics and outcome measures of the studies included, which could introduce heterogeneity. Some studies included modified versions of LASIK (e.g., FS-LASIK) and PRK (e.g., WFG PRK), which may have different outcomes than conventional techniques. Lastly, study populations varied in the severity of myopia. This could potentially influence the outcome measures, as the risks or complications experienced by patients with high myopia might be different from those experienced by patients with mild myopia.

RCTs have demonstrated similar efficacy and safety for LASIK and PRK, with the two myopia treatment procedures generally resulting in comparable outcomes even at 2 years after surgery. LASIK may offer advantages in terms of recovery and patient satisfaction compared to PRK. Compared with conventional LASIK and PRK, WFG LASIK and WFG PRK show better outcomes in reducing HOA. Effective myopia control should prioritize early detection through regular refractive screening, timely optical correction, and the implementation of evidence-based myopia control strategies. For adults requiring refractive surgery, individualized procedure selection based on corneal characteristics, visual demands, and patient expectations is essential. Further trials are needed to analyze other outcome variables, such as cost-effectiveness and patient satisfaction. Sub-group analysis regarding the degree of myopia and differences between modified and conventional procedures can provide new findings as to whether there are differences between the two procedures.

Author Contributions

IBC: Conceptualization, Methodology, Validation, Investigation, Data Curation, Writing – Original draft preparation, Supervision, Project administration; AFP: Software, Formal Analysis, Resources, Writing – Review and editing, Visualization.All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

Funding

All authors declare that this study received no external funding. All research activities were conducted without financial support from any funding agency, commercial entity, or non-profit organization.

Acknowledgements

All authors would like to thank all researchers whose studies were included in this systematic review and meta-analysis.

Disclaimers

The opinions expressed in this article are solely those of the authors and do not necessarily reflect the official policy or position of their affiliated institutions.

Ethics Statement

Ethical approval was not required for this study because it is based on previously published data and does not involve any new research with human participants or animals. The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD42025628097

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Abbreviations

LASIK – Laser-Assisted In-Situ Keratomileusis; PRK – Photorefractive Keratectomy; EPHPP – Effective Public Health Practice Project; OR – Odds Ratios; CI – Confidence Intervals; RCT – Randomized Controlled Trial; UCVA – Uncorrected Visual Acuity; D – Diopter; BCVA – Best corrected visual acuity; SD – Standart deviation; SE – Spherical Equivalent; FDA – Food and Drug Administration.

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