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REVIEW ARTICLE OPEN ACCESS

Conventional *Versus* Transepithelial Photorefractive Keratectomy: A Review of Clinical Outcomes

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Abstract:
Refractive errors, including myopia, hyperopia, and astigmatism, can impair vision and require corrective solutions, such as glasses, contact lenses, or surgical intervention. Photorefractive Keratectomy (PRK) and transepithelial PRK (TPRK) are two surface ablation laser procedures commonly used to correct refractive errors by reshaping the cornea. PRK, a widely used technique, involves mechanical or alcohol-assisted removal of the corneal epithelium before applying an excimer laser to ablate the stromal tissue. Although effective, PRK is associated with post-operative discomfort, longer recovery times, and potential consequences, such as corneal haze and regression. Alternatively, TPRK, introduced as an advancement over PRK, utilizes an excimer laser for both epithelial removal and stromal ablation in a single step, eliminating the need for mechanical scraping or alcohol application. This technique reduces surgical time, minimizes epithelial trauma, and enhances healing, leading to faster visual recovery and less post-operative pain. TPRK maintains similar efficacy to PRK while improving patient comfort and reducing complications. Despite these advantages, both procedures have contraindications and additional postoperative consequences. Moreover, Artificial Intelligence (AI) is increasingly shaping ophthalmology by enhancing diagnostic precision and supporting refractive surgery planning. Machine learning models contribute to improved patient selection, prediction of surgical outcomes, and refinement of procedures such as PRK and TPRK. In this review, we compare visual and refractive outcomes, complications, and patient satisfaction between conventional PRK and TPRK, while also addressing the emerging role of AI in corneal refractive surgery. Further well-designed studies are needed to establish standardized treatment protocols and improve patient-reported clinical outcomes, such as corneal stability and higher-order aberrations.

Keywords: Photorefractive keratectomy, Transepithelial photorefractive keratectomy, Contraindications, Complications, Treatment, Artificial intelligence.

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1. INTRODUCTION

Refractive errors occur when the eye cannot properly focus light, causing blurred vision[1]. This is commonly due to myopia (nearsightedness), hyperopia (farsightedness), astigmatism, or presbyopia. Uncorrected refractive errors may cause progressive vision loss, discomfort, headaches, and reduced quality of life [1, 2]. Factors like genetics, aging, and environmental influences contribute to refractive errors [3]. Routine eye exams are essential for early detection and management, reducing the risk of long-term visual impairment and associated difficulties in daily activities. Although laser corneal refractive surgery has emerged as an effective alternative to optical correction with glasses or contact lenses, a wide range of surgical techniques has been developed to correct refractive errors by removing corneal tissue and reshaping the cornea [2, 3]. Surgical treatment offers a solution to some of the limitations of spectacles and contact lenses, including the discomfort associated with glasses and their impracticality for sports, as well as the risk of corneal infections commonly linked to contact lenses. Surface corneal refractive surgery is a safe and effective option for patients with epithelial basement membrane lesions and a thin cornea with high myopia [4]. Excimer laser systems have been widely utilized in various refractive procedures, including Photorefractive Keratectomy (PRK), followed by Laser *in Situ* Keratomileusis (LASIK), Small Incision Lenticule Extraction (SMILE), and Transepithelial PRK (TPRK), demonstrating their versatility in vision correction treatments [5]. The ongoing debate regarding the use of various surgical procedures, particularly PRK and TPRK, is well-documented and extensively explored in the literature.

This review provides a brief overview of both techniques, discussing technical considerations, contra-indications, and emphasizing postoperative outcomes, potential complications, management, and the role of Artificial Intelligence (AI)-driven technology.

2. METHODOLOGY

To ensure transparency and scientific rigor, we conducted a narrative review on *Conventional versus Transepithelial Photorefractive Keratectomy: Long-Term Outcomes and the Role of AI-Driven Technology*. A comprehensive search of PubMed, Scopus, and Web of Science was performed up to July 2025. The search strategy combined the following keywords with Boolean operators (AND/OR): *"Photorefractive Keratectomy, Transepithelial Photorefractive Keratectomy, Contraindications, Complications, Treatment, and Artificial Intelligence."*

Eligible studies included original research articles, reviews, and clinical investigations published in English that addressed conventional *versus* transepithelial photorefractive keratectomy, long-term outcomes, and/or AI applications in this field. Screening was conducted based on titles and abstracts, followed by full-text assessment. Studies unrelated to the comparative long-term effects of the two procedures or lacking relevance to AI-driven technologies were excluded.

Selected articles were analyzed qualitatively with emphasis on mechanistic insights, clinical relevance, and therapeutic outcomes. Findings were categorized into thematic sections covering surgical techniques, post-operative effects, and complications. As this is a narrative review, no meta-analytical methods were applied.

2.1. Technical Considerations and Surgical Procedures

PRK is a common surface ablation technique used to correct refractive errors, such as myopia and astigmatism, by reshaping the cornea [6]. By eliminating the need for a lamellar flap and its associated risks, this procedure is especially suitable for patients with thinner corneas, larger pupillary diameters, and low to moderate myopia [7]. By modifying the corneal curvature, this procedure improves light focus on the retina, enhancing visual clarity [8]. Unlike LASIK, in PRK, the corneal epithelium is manually removed (often with the aid of topical alcohol or with a brush) within a defined diameter that accommodates the planned ablation zone. This is followed by stromal ablation using the ultraviolet excimer laser beam (193 nm argon fluoride) applied to the anterior corneal surface, reshaping its curvature to enhance light focus on the retina, rather than creating a flap [6, 9]. The epithelium typically regenerates within a few days, leading to temporary postoperative discomfort. In some cases, healing may take longer. In addition, mild subepithelial opacities (known as corneal haze) may develop, potentially affecting both the quality and quantity of vision [10]. Although this procedure has been studied since 1980, its method may lead to epithelial removal with an uneven edge and a larger area than necessary for proper stromal exposure [11-13]. Since the introduction of PRK, the procedure and laser technology used have been substantially improved. Many techniques have been developed, adopted, and added to PRK, including laser-diluted alcohol and a rotating brush [7]. A technique using an alcohol solution for epithelium removal, called Laser-Assisted Sub-Epithelial Keratectomy (LASEK), was introduced as a modification of PRK to speed up the healing process and improve stromal hydration [9, 14]. The alcohol solution used in the procedure assists in loosening the corneal epithelium before lifting the flap, rather than removing it entirely [14]. After laser ablation, the epithelial flap is repositioned, promoting faster healing and less pain compared to conventional PRK. Although PRK is beneficial for patients with thin corneas or those at risk for flap complications, it may cause pain after surgery, slow epithelial healing, longer recovery time, and corneal haze when compared to LASIK [15, 16]. An enhancement to this technique involved using an excimer laser to remove the epithelium, followed by refractive stromal ablation in a seamless, no-touch approach known as transepithelial PRK.

Transepithelial PRK (TPRK) was introduced in the 1990s [17]. It is an advanced version of PRK, designed to improve precision and patient comfort [18]. Unlike conventional PRK, TPRK uses an excimer laser to perform a single-step epithelial removal and stromal ablation, ensuring that no surgical instruments come into direct contact with the cornea [19, 20]. This ensures uniform ablation, reduces epithelial trauma, and potentially leads to faster healing and less post-operative pain [21]. The procedure underwent several modifications to reach the desired refractory correction [22]. Both PRK and TPRK reshape the corneal stroma to correct refractive errors, with the choice of procedure depending on the patient's preferences and the desired correction outcome. Both techniques are commonly performed yet challenging procedures, and their effectiveness has been extensively compared in the literature. The indications for TPRK are similar to those of conventional PRK for treating both moderate and high levels of myopia [8]. Although the value of a 250 μm residual stromal bed after excimer ablation in LASIK remains a historical reference, current literature suggests that values above 275–300 μm may be safer. However, the decision should be based on a comprehensive assessment that includes corneal topography/ tomography, the percentage of tissue altered (PTA), and other individual risk factors. There is no single international consensus, and the recommendation should be adapted to the surgical protocol and the patient's individual characteristics. In general, however, it is recommended that the maximum PTA limit should be 40% [23].

Recently, TPRK has increasingly replaced conventional PRK due to its non-contact, fully automated approach, improving visual recovery, and lowering the risk of postoperative complications [21, 24-27]. Nevertheless, patient satisfaction and pain relief are considered the most challenging issues to address, as well as the advantages and disadvantages of these procedures. One of the common advantages of TPRK is that the procedure can be beneficial for corneas affected by previous surgeries, such as keratoplasty and keratotomy [28]. Astigmatism occurring after keratoplasty and treated with LASIK frequently causes refractive regression, corneal stromal haze, and perforation [7]. However, TPRK in post-keratoplasty or keratotomy was found to be a safe and effective procedure [7].

2.2. Procedural Contraindication

Contraindications to PRK and TPRK include systemic, ocular, and corneal factors that may impair healing or increase surgical risks [18]. Systemic conditions include rheumatoid arthritis and uncontrolled diabetes mellitus. Ocular contraindications involve acute inflammatory infection of the cornea, a previous history of herpes keratitis, and unstable refraction in young or progressive myopic patients, as well as reduced corneal thickness, stromal scarring, vascularization, and ectatic conditions like keratoconus. Hormonal fluctuations, such as those that occur during pregnancy, may cause refractive changes. Additionally, uncontrolled glaucoma and steroid responders pose risks after chronic steroid use required to treat corneal haze [18]. Moreover, treatment of lower-order refractive errors may cause higher-order abnormalities that decrease visual acuity [29].

2.3. Preoperative Assessment and Procedure Selection

Proper preoperative assessment and postoperative management are crucial for achieving optimal outcomes in PRK and TPRK. Before surgery, a comprehensive eye examination is performed, including corneal topography, pachymetry, and refraction assessment to determine patient eligibility. Patients with thin corneas or high myopia may benefit from surface ablation techniques, such as PRK or TPRK [24]. The procedure choice is optional, based on the patient's desire, risk, and eligibility. Whether using PRK or TPRK, the choice between them became an interesting research and treatment challenge.

Initially, the TPRK 2-step technique was introduced worldwide; however, it was not commonly used due to prolonged surgery times with the older generation of lasers, corneal dehydration, increased postoperative pain, and a deficiency in adjusted nomograms [30, 31]. When new generations emerged, a new TPRK non-touch surface ablation procedure was developed, allowing for corneal epithelial and stromal ablation in a single step [32]. Single-step TPRK is a recently developed procedure that offers several benefits, including shorter surgery time, minimized epithelial defects, elimination of alcohol use, reduced postoperative pain, a lower risk of corneal haze, accelerated healing, and faster visual recovery [25, 26, 33]. The Schwind Amaris system (Kleinostheim, Germany) integrates PRK into a single-step reverse PRK, enabling precise correction in a streamlined approach [25]. The "Smart Pulse" ablation program (Kleinostheim, Germany) also employs various ablation spots to minimize thermal load and enhance the softness of the ablation bed [34]. A retrospective study found that this approach can lead to a faster recovery, less pain during the initial days, and a minor incidence of stromal haze [25]. The Alcon Streamlight, added to the EX500 Excimer laser in 2019, is a single-step TPRK platform for precise ablation in 5μm steps, adjusting to corneal thickness while maintaining a refractively neutral approach [35]. Similar to the Schwind program, there is no disruption between epithelial and stromal ablations, which reduces treatment time.

Postoperatively, corneal epithelial healing is monitored using serial imaging of the corneal epithelial defect (CED) [36]. Pain, discomfort, and inflammation are managed with bandage contact lenses, topical antibiotics, corticosteroids, and lubricants. Patients are assessed for visual recovery, refractive stability, and potential complications, such as corneal haze. Healing times, pain levels, and epithelial regeneration rates vary between PRK and TPRK, influencing postoperative care and patient experience.

2.4. Postoperative Consequences in PRK *versus* TPRK

Postoperative consequences or complications related to surface ablation are frequently observed in patients undergoing refractive keratectomy. However, surface ablation is considered a safer option as it eliminates the risk of flap-related complications, corneal fading, and the increased likelihood of keratectasia. As a result, surface ablation has emerged as a viable alternative [37]. One of the common problems associated with PRK is undercorrection and refractive regression [38]. Primary undercorrection is influenced by epithelial and stromal healing, axial and lenticular myopia, corneal reshaping, and hormonal changes from pregnancy or endocrine disorders [39]. The percentage of patients who require redo surgery after the first correction with an excimer laser is about 7% [40]. PRK for residual refractive error after LASIK shows outcomes comparable to PRK on untreated eyes by six months [40]. Early differences in higher-order aberrations and achieved MRSE were observed in hyperopic post-LASIK cases, but these differences diminished over time. Importantly, PRK represents a safe and effective option for post-LASIK corrections, thereby avoiding the risks associated with repeat LASIK, including flap-related complications.

Table 1. The characteristic patterns and the differences between conventional photorefractive keratectomy (PRK) *versus* transepithelial photorefractive keratectomy (TPRK).

Feature	Conventional PRK	Transepithelial PRK (TPRK)
Surgical Procedure	Epithelial removal with alcohol or a rotating brush, followed by laser ablation	No-touch surface ablation without alcohol or mechanical scraping
Flap Creation	No flap creation, surface ablation	No flap creation, surface ablation
Epithelium Removal	Manually removed using alcohol or a mechanical brush	Removed and ablated in a single-step laser procedure
Surgical Time	Longer, requires separate epithelium removal	Faster, performed in a single laser step
Alcohol Use	Often requires alcohol to loosen the epithelium	No alcohol used
Recovery Time	Longer initial recovery (several days to weeks)	Faster recovery than conventional PRK but longer than LASIK
Postoperative Pain	More discomfort due to full epithelium removal	Less pain due to a smaller epithelial defect
Corneal Haze Risk	Higher risk compared to TPRK	Lower risk, but still present in some cases
Dry-Eye Symptoms	Less dry-eye symptoms than with LASIK	Similar to conventional PRK, but with less discomfort overall
Suitability for Thin Corneas	May be suitable	May be suitable
Enhancement Procedures	Possible	Possible
Overall Vision Quality	Excellent, but takes longer to stabilize	Excellent, but may take longer to stabilize

As such, PRK is often favored as a redo surgery technique, offering stable long-term results and maintaining corneal integrity while effectively addressing residual myopia or hyperopia.

Furthermore, the potential development of corneal opacity (haze) is a significant limitation of PRK and a notable long-term complication. Haze formation is influenced by deeper ablation for high myopia, epithelial basement membrane integrity, and abnormal extracellular matrix deposition during corneal healing [41]. The differences between the two procedures in terms of effect, consequences, and complications are summarized in Table **1**.

In 2013, a meta-analysis by Shortt *et al*. concluded that LASIK provides faster recovery and greater comfort but carries risks related to flap creation and ectasia. PRK avoids flap complications and ectasia but is associated with slower recovery, more postoperative discomfort, and a higher risk of corneal haze unless mitigated with Mitomycin C [42]. Retreatment may be needed due to decentration, small optical zone, or aberrations [7]. Another, less frequent, long-term complication that can be induced by PRK is corneal ectasia. The risk of ectasia is lower after surface ablation compared to LASIK. A literature review by Randleman *et al*. (1997–2005) found that 95% of reported ectasia cases followed LASIK, while only 4% occurred after surface ablation [40]. A recent meta-analysis by Alasbali *et al*. included 957 patients and compared visual and patient-reported outcomes between the two procedures [3]. More than 12 published studies from 2016 to 2023 have examined the outcomes, as documented by Alasbali *et al* [3]. Their findings suggest that TPRK demonstrates superiority over conventional PRK in terms of procedural accuracy and a lower incidence of postoperative complications, based on predictive outcome measures. Single-step TPRK was associated with faster epithelial healing and reduced pain after surgery compared to PRK, while the rate of postoperative corneal haze remained similar [3, 43]. The reduction in pain is likely multifactorial and may be attributed to faster re-epithelialization. This occurs because TPRK removes a smaller epithelial area compared to conventional methods, which is present in alcohol-assisted PRK [44]. Although surgical outcomes have been addressed, their relationship with patients' outcomes is less discussed [45]. Among the studies reviewed in the Alasbali analysis [3], only two examined patient satisfaction, both of which reported higher satisfaction with TPRK [11, 46].

Gadde *et al*. also compared the uncorrected visual acuity (UCVA) after surgery with corrected visual acuity (CVA) post-surgery between TPRK and PRK in 59 patients [9]. Both procedures showed similar visual outcomes over 3.5 months, but TPRK had a higher incidence of corneal haze. Similarly, Bakhsh *et al*. reported comparable efficacy between PRK and TPRK at 6 months, Antonios *et al*. confirmed similar findings at 12 months, and Rodriguez *et al*. published the longest follow-up to date (mean 35.2 ± 5.0 months, range 30–46 months), also reporting comparable results [11, 47, 48]. Ghobashy *et al*. reported that TPRK can be a safer, less painful, and effective alternative to PRK [49]. The transepithelial group achieved complete healing in an average of 2.5 days, compared to 3.7 days in the conventional PRK group [27]. Two studies performed by Ellakava *et al*. and Ghobashy *et al*. found favourable outcomes with TPRK, whereby the healing process was faster and pain was less [49, 50]. Visual recovery is slower, often taking weeks for full stabilization. There is a higher risk of corneal haze, especially in high myopia cases, and an increased chance of infection or inflammation due to delayed epithelial healing [3, 51]. Patients must use bandage contact lenses and follow a strict postoperative medication regimen. Additionally, PRK requires more downtime, making it less convenient for those needing a quick recovery.

A study by Naderi *et al*. in 2016 compared TPRK and PRK for low to moderate myopia [52]. Among 170 patients, TPRK demonstrated lower postoperative pain (p = 0.04), faster epithelial healing, and better visual acuity at two months. Additionally, safety and efficacy indexes were significantly better in TPRK, suggesting its superiority in terms of patient comfort and visual recovery. On the other hand, Hashemi *et al*. conducted a similar study in 2022, comparing TPRK, mechanical PRK (mPRK), and alcohol-assisted PRK (aaPRK) in terms of epithelial healing, pain, and visual outcomes [24]. While all three techniques were effective, conventional PRK exhibited a faster healing rate relative to the initial defect area, whereas TPRK patients reported less postoperative pain and discomfort, despite similar overall healing times. Both studies confirm that TPRK is a safe and effective alternative to PRK, with Hashemi *et al*. [24] highlighting the healing rate differences, while Naderi *et al*. [52] emphasized the advantages of TPRK in reducing pain and accelerating recovery. Patient satisfaction is increasingly recognized as a critical measure of refractive surgery success. The limited evidence available suggests that TPRK provides a more comfortable postoperative experience, largely due to reduced pain and faster recovery. Patients undergoing TPRK reported higher satisfaction compared to conventional PRK, reflecting not only improved visual outcomes but also enhanced quality of life during the healing process. Although current data are scarce, these findings emphasize the need for more systematic evaluations of patient-reported outcomes to validate TPRK's advantages in clinical practice.

Other rare postoperative consequences are biomechanical stability and wave-front guided aberrations. Corneal laser refractive surgery may cause biomechanical instability, increasing the risk of post-surgical corneal ectasia [40]. While factors such as a low residual stromal bed and high tissue removal contribute to this condition, some cases develop years later without a clear cause [23]. Xin *et al*. compared corneal stiffness after TPRK and LASIK, finding that both techniques reduce stiffness [53]. However, TPRK resulted in the least reduction, suggesting it may better preserve corneal biomechanics compared to other techniques, potentially reducing the risk of long-term structural complications. TPRK was also associated with a higher incidence of high-order aberrations (HOAs) than conventional PRK [19]. Chen *et al*. [44] observed HOAs in TPRK compared to lenticular extraction, even with wavefront-guided (WFG) treatment. However, in patients with pre-existing high HOAs, WFG TPRK did not significantly elevate HOAs compared to aberration-free treatments [54].

2.5. Management of Postoperative Complications

The management of postoperative corneal pain, corneal haze, corneal ectasia, and wavefront-guided aberrations is a widely studied topic in the literature. These complications are common with PRK than with TPRK. Postoperative pain management following PRK or TPRK involves various strategies to enhance patient comfort and promote healing [18]. Topical nonsteroidal anti-inflammatory drugs (NSAIDs) like nepafenac 0.1% and ketorolac 0.4% have been shown to provide effective pain relief without hindering corneal epithelial healing [55]. Additionally, gabapentin has been evaluated as an alternative to traditional analgesics. A study comparing gabapentin to oxycodone/acetaminophen found no significant difference in overall pain management ratings between the two groups, suggesting gabapentin's viability as a postoperative pain management option [56]. In clinical practice, high-volume PRK surgeons often employ a combination of topical steroids, NSAIDs, and soft contact lenses immediately postoperatively to manage pain and facilitate healing. Corneal haze is a significant complication following surface ablation procedures like PRK. Heitzmann's 1993 grading system classifies corneal haze from grade 0 (clear cornea) to grade 5 (severe opacity) [56]. Grades 0–2 are typically treated with topical steroids, though their long-term efficacy remains controversial due to potential side effects like increased intraocular pressure (IOP) [7]. More advanced haze (grades 2–4) may require mechanical epithelial debridement or laser scraping. Phototherapeutic keratectomy (PTK) combined with mitomycin-C (MMC) application has proven effective in reducing corneal opacity [7].

Dry eye syndrome, commonly observed after PRK, must be promptly managed to maintain visual quality. Treatment includes preservative-free artificial tears, cyclosporine drops, and management of lid disease [7, 42]. It has been demonstrated that punctal plugs improve visual acuity in patients with lower refractive errors. Corneal ectasia after refractive surgery has been traditionally managed with rigid gas-permeable lenses and intracorneal ring segments [57]. In comparison, literature on TPRK suggests a similar approach for managing haze, with the added benefit of less postoperative haze due to the single-step epithelial removal technique [18]. TPRK patients experience fewer complications and require less aggressive interventions, highlighting its advantage in reducing corneal haze and enhancing long-term outcomes.

HOAs can be treated through wavefront-guided retreatment. Utilizing corneal elevation data from topography, along with clinical information, allows for the development of customized treatments aimed at minimizing second-order aberrations and higher-order aberrations (HOAs). Research has demonstrated that wavefront-guided retreatments can effectively reduce HOAs and corneal spherical aberrations, thereby enhancing visual acuity [6]. By analyzing how the optical system modifies an incoming wavefront of light, wavefront aberrometry can identify subtle ocular aberrations.

2.6. AI-Driven Technology in PRK and TPRK Ablation

The potential of AI in ophthalmology continues to be explored, demonstrating its capacity to revolutionize vision care [58]. While AI is not expected to replace ophthalmologists, it has the potential to augment patient care by improving diagnostic performance and predicting possible outcomes. AI has already been applied in detecting and managing conditions, such as diabetic retinopathy, age-related macular degeneration, glaucoma, and cataracts, with ongoing research into its role in corneal disorders [59]. Research efforts are increasingly focusing on enhancing AI-driven screening and grading of diseases in clinical settings, aiming for higher accuracy and efficiency. Various machine learning (ML) algorithms have been developed to identify eyes with preclinical or subclinical keratoconus [60], enabling early detection of corneal ectasias before refractive surgery and identifying cases where surgery may be contraindicated [61]. A model trained on preoperative data from 10,500 eyes achieved 94% accuracy in predicting refractive surgery suitability, including procedures like laser-assisted epithelial keratomileusis (LASIK) and small incision lenticular extraction (SMILE) [62]. AI, designed to mimic human cognitive processes, has evolved significantly from early rule-based models that relied on predefined expert knowledge.

The introduction of convolutional neural networks (CNNs) in 2012, proposed by LeCun *et al*., marked a technological breakthrough, enabling deep neural networks to achieve state-of-the-art performance in imaging applications [63]. CNNs automatically learn multiscale feature representations by applying convolutional filters and nonlinear activation functions to images at various scales, refining their weights during training through iterative backpropagation. Convolutional layers enhance specific features in an image, while pooling layers perform dimensionality reduction to optimize computational efficiency [64]. These advancements have made AI highly effective in diagnosing various corneal disorders, including infectious keratitis (IK), keratoconus, pterygium, endothelial diseases, and complications related to corneal grafts [64]. Given the increasing demand for optimal visual and refractive outcomes with minimal postoperative complications, AI research in refractive surgery has gained momentum, particularly in preoperative risk assessment for post-laser corneal ectasia, surgical procedure selection, and automated refraction. Utilizing Orbscan II tomography, Saad and Gatinel developed a linear discriminant model with 93% sensitivity and 92% specificity in detecting post-LASIK ectasia [65]. Building on this foundation, subsequent research has integrated advanced corneal imaging modalities, such as Scheimpflug tomography, anterior segment OCT, and biomechanical assessments to further strengthen ectasia prediction. Machine learning models, including random forests and deep neural networks, have demonstrated superior accuracy by capturing complex, nonlinear interactions among topographic and biomechanical variables. AI has also been applied to refine surgical procedure selection, guiding clinicians in choosing between LASIK, PRK, or SMILE based on individualized corneal characteristics and risk profiles. Furthermore, automated refraction systems utilizing AI-driven algorithms now provide rapid and reproducible measurements that reduce examiner variability. Collectively, these developments highlight AI's potential to enhance surgical safety, personalize treatment planning, and improve refractive outcomes for patients undergoing corneal laser surgery.

Beyond screening, AI has been employed in selecting appropriate refractive surgery types and optimizing surgical nomograms. Yoo *et al*. developed a multiclass ML model that categorized patients into laser epithelial keratomileusis, LASIK, SMILE, and contraindication groups, using data from 18,000 subjects. Their model achieved 81% accuracy in internal validation and 79% in external validation [62]. Similarly, Cui *et al*. developed an ML-based nomogram for SMILE surgery to achieve precise visual outcomes, demonstrating that 93% of eyes in the ML-guided group had a postoperative refractive error within 0.50D compared to 83% in the surgeon-guided group. The ML-based approach also showed superior safety and efficacy indices [66]. Given the variability in topographic map interpretation and differences between diagnostic devices, AI-driven case selection and procedural decisions are crucial for optimizing surgical outcomes. Certain organizations have even implemented AI-based screening to identify prior refractive surgery in potential employees or recruits [67]. Moreover, AI models are being developed to enhance refractive surgery outcome predictions, where performance metrics now rival those of experienced surgeons in terms of safety, efficacy, and predictability. AI can also assist in preventing miscalculations and optimizing intraocular lens (IOL) power selection to minimize residual refractive errors [68]. ML techniques applied to vast corneal examination datasets have yielded promising results, but selecting the most appropriate indices and algorithms remains an area of ongoing research [69].

More recently, large language models (LLMs), such as Generative Pre-trained Transformer Version 4 (GPT-4) from OpenAI, have garnered interest for their potential to serve as general AI across multiple disciplines [70]. Unlike domain-specific AI applications, LLMs dynamically adapt to evolving knowledge bases and can process extensive textual information, making them versatile tools for various applications. While preliminary tests have assessed LLMs in healthcare scenarios, their capabilities remain under scrutiny. Some studies have evaluated ChatGPT-4's diagnostic triage abilities against other AI-based diagnostic tools, such as ChatGPT-3.5 and Ada (Ada Health GmbH), revealing that ChatGPT-4 underperformed in comparison [71]. Similarly, multiple recent studies indicate that while ChatGPT exhibits some diagnostic capabilities, its reliability remains inconsistent [72]. Known limitations include logical inconsistencies, hallucinations, and prompt-dependency, raising concerns about its applicability in medical contexts. Despite these shortcomings, ChatGPT and other large language models continue to evolve, with newer versions showing improved accuracy, contextual understanding, and reduced hallucinations. Integration with domain-specific datasets and reinforcement learning from expert feedback has been explored to enhance medical reliability. Moreover, hybrid approaches combining AI outputs with clinician oversight are being proposed to mitigate risks while leveraging efficiency in tasks, such as patient education, drafting clinical notes, and preliminary triage. Ethical considerations, including patient privacy, data security, and accountability, remain central. Thus, while current reliability is limited, ChatGPT holds promise as a supportive—not standalone—tool in healthcare. Circovic's study on AI applications in refractive surgery examined ChatGPT-4's ability to classify patients based on clinical parameters compared to an experienced refractive surgeon. Analyzing data from 100 patients, the study found moderate agreement between AI and the surgeon, with ChatGPT-4 performing well in binary categorization but exhibiting variability in other cases [73]. Despite its limitations, this study emphasizes AI's potential in refractive surgery decision-making, highlighting the need for further research to refine its applications. As AI technology continues to evolve, its integration into ophthalmology, particularly corneal diagnostics and refractive surgery, is expected to advance, leading to more precise, efficient, and personalized patient care.

CONCLUSION

PRK and TPRK are both effective surface ablation procedures for the correction of refractive errors, offering established and safe alternatives to LASIK, particularly for patients with thin corneas, irregular topography, or those prone to flap-related complications. PRK has a long record of safety and predictability, while TPRK offers additional benefits, including improved precision of ablation, faster epithelial healing, reduced postoperative discomfort, and comparable visual and refractive outcomes. Nevertheless, important gaps remain. The long-term biomechanical stability of the cornea following surface ablation requires further exploration, particularly in younger patients or those undergoing high corrections. Similarly, higher-order aberrations remain a concern that may compromise visual quality, warranting careful long-term monitoring. Moreover, while AI-driven approaches, including machine learning algorithms, are increasingly being applied for ectasia risk assessment, surgical planning, and patient counseling, their clinical reliability requires validation in prospective, real-world trials. Addressing these gaps will refine patient selection, enhance safety, and optimize personalized treatment strategies in refractive surgery.

AUTHOR'S CONTRIBUTIONS

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

LIST OF ABBREVIATIONS

PRK	=	Photorefractive keratectomy
TPRK	=	Transepithelial photorefractive keratectomy
AI	=	Artificial intelligence
LASIK	=	Laser *in situ* keratomileusis
SMILE	=	Small incision lenticule extraction

CONSENT FOR PUBLICATION

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