ORIGINAL RESEARCH

Comparative Analysis of LASIK and SMILE Techniques in Treating Myopia

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ABSTRACT

Aim: This study aimed to compare the efficacy, safety, and patient satisfaction of Laser-Assisted In Situ Keratomileusis (LASIK) and Small Incision Lenticule Extraction (SMILE) techniques in the treatment of myopia. **Materials and Methods:** A prospective, comparative study was conducted on 100 myopic patients who were randomly allocated into two equal groups: LASIK (n = 50) and SMILE (n = 50). Inclusion criteria included patients aged 18–40 years with stable myopia (-1.00 to -10.00 D) and a minimum corneal thickness of 500 µm. Preoperative assessments included uncorrected and best-corrected visual acuity (UCVA, BCVA), manifest and cycloplegic refraction, corneal topography, pachymetry, tear film assessment, and intraocular pressure measurement. Postoperative evaluations were performed at Day 1, Week 1, Month 1, Month 3, and Month 6 to assess visual acuity, refractive error, corneal integrity, dry eye symptoms, and patient-reported satisfaction. **Results:** Baseline characteristics, including age, gender distribution, preoperative UCVA, BCVA, spherical equivalent, and corneal thickness, were comparable between the groups ($p > 0.05$). Postoperative UCVA improved progressively in both groups, with no significant difference at six months (LASIK: 0.06 ± 0.02 LogMAR, SMILE: 0.07 ± 0.02 LogMAR, $p = 0.50$). Residual refractive error was minimal in both groups, with values of -0.08 ± 0.05 D for LASIK and -0.10 ± 0.06 D for SMILE at six months ($p = 0.60$). Corneal thickness was better preserved in the SMILE group (488 ± 19 µm for LASIK vs. 493 ± 18 µm for SMILE; $p = 0.38$). Dry eye symptoms were significantly higher in the LASIK group at one week (OSDI: 25.0 ± 5.1 vs. 18.5 ± 4.8, $p < 0.01$), but the difference became non-significant by six months. Patient satisfaction remained high, with 96% satisfaction in both groups at six months ($p = 0.75$). **Conclusion:** Both LASIK and SMILE are effective, safe, and reliable procedures for myopia correction, providing excellent postoperative visual outcomes with minimal residual refractive error. While LASIK offered slightly faster visual recovery, SMILE preserved corneal integrity better and was associated with fewer dry eye symptoms. The choice between LASIK and SMILE should be guided by individual patient characteristics and ocular health considerations.

Keywords: LASIK, SMILE, Myopia Correction, Corneal Biomechanics, Visual Acuity

INTRODUCTION

Myopia, commonly known as nearsightedness, is a prevalent refractive error that affects millions of individuals worldwide. Characterized by the inability to clearly see distant objects while maintaining clarity in near vision, myopia has become a major concern in ophthalmology. The increasing reliance on digital screens, reduced outdoor activity, and genetic predisposition have contributed to a global rise in myopia cases. As a result, there has been significant advancement in refractive surgical procedures aimed at correcting myopic vision, offering patients an alternative to traditional glasses and contact lenses. Among these, Laser-Assisted In Situ Keratomileusis (LASIK) and Small Incision Lenticule Extraction (SMILE) are two of the most widely performed laser-based corrective surgeries. Both techniques have revolutionized vision correction, but they differ in procedural approach, safety profiles, effectiveness, and long-term outcomes.[1]

LASIK has been the gold standard in refractive surgery for decades. It involves creating a corneal flap using either a microkeratome or a femtosecond laser, followed by the reshaping of the underlying corneal tissue with an excimer laser to correct refractive errors. The flap is then repositioned, allowing for rapid healing and improved vision within a short recovery period. The effectiveness of LASIK in treating low to moderate myopia has been well established, with high patient satisfaction rates and minimal post-operative discomfort. However, LASIK is associated with potential complications such as flap

dislocation, dry eye syndrome, and an increased risk of ectasia, which may limit its suitability for certain patients. Despite these concerns, LASIK remains one of the most commonly performed elective procedures worldwide due to its proven efficacy and rapid visual recovery.[2]

SMILE, on the other hand, is a relatively newer technique that offers a minimally invasive alternative to LASIK. This procedure involves using a femtosecond laser to create a small lenticule within the corneal stroma, which is then removed through a tiny incision, altering the corneal shape to achieve refractive correction. Unlike LASIK, SMILE does not require the creation of a flap, reducing the risk of flap-related complications. Additionally, SMILE has been associated with better corneal biomechanical stability, lower rates of post-operative dry eye, and a reduced likelihood of inducing higher-order aberrations. These advantages make SMILE a preferred choice for patients with higher myopia and those at risk of developing dry eye syndrome. However, SMILE has limitations, including a longer learning curve for surgeons, potential difficulty in retreatment, and slightly delayed visual recovery compared to LASIK.[3]

Given the distinct characteristics of LASIK and SMILE, there has been a growing interest in comparing their effectiveness, safety, and patient outcomes. Factors such as visual acuity improvement, post-operative complications, corneal stability, and overall patient satisfaction play a crucial role in determining the superiority of one technique over the other. While LASIK has a longer track record with extensive clinical data supporting its use, SMILE is gaining popularity due to its minimally invasive nature and potential biomechanical advantages.[4-6]

This comparative analysis aims to evaluate the benefits and limitations of LASIK and SMILE in treating myopia, considering their procedural differences, clinical outcomes, and long-term efficacy. By examining various aspects such as visual recovery, complication rates, and patient-reported experiences, this study seeks to provide a comprehensive understanding of the two techniques, helping both patients and ophthalmologists make informed decisions regarding refractive surgery options.

MATERIALS AND METHODS

A prospective, comparative study was conducted to evaluate the efficacy, safety, and patient satisfaction of Laser-Assisted In Situ Keratomileusis (LASIK) and Small Incision Lenticule Extraction (SMILE) techniques in the treatment of myopia. The study included 100 patients diagnosed with myopia, who were randomly allocated into two equal groups: the LASIK group (n = 50) and the SMILE group (n = 50).

Inclusion and Exclusion Criteria

Patients aged 18 to 40 years with stable myopia (-1.00 to -10.00 D) and a minimum corneal thickness of 500 µm were included in the study. Exclusion criteria included patients with keratoconus, ocular surface diseases, severe dry eye syndrome, autoimmune disorders, prior ocular surgeries, or pregnancy/lactation.

Preoperative Assessment

All participants underwent a comprehensive ophthalmic examination, including:

- Uncorrected and best-corrected visual acuity (UCVA, BCVA)
- Manifest and cycloplegic refraction
- Corneal topography (Pentacam, Oculus GmbH, Germany)
- Pachymetry
- Tear film assessment using Schirmer's test
- Intraocular pressure measurement (Goldmann Applanation Tonometry)

Surgical Techniques

LASIK Procedure: The LASIK procedure was performed using the VisuMax femtosecond laser (Carl Zeiss Meditec, Germany) for flap creation, followed by excimer laser ablation with the MEL 90 (Carl Zeiss Meditec, Germany). The corneal flap (100-120 µm thick) was lifted, and the stromal ablation was customized according to the patient's refractive error. Postoperative flap repositioning was performed without sutures.

SMILE Procedure: The SMILE procedure was carried out using the VisuMax femtosecond laser to create an intrastromal lenticule. The lenticule was dissected and removed through a small incision of approximately 2-3 mm, without the creation of a flap.

Postoperative Care and Follow-up Postoperative care was standardized for both groups. Patients were prescribed topical antibiotics (moxifloxacin 0.5%) for one week and corticosteroid eye drops (fluorometholone 0.1%) tapered over four weeks. Artificial tear supplements were advised for three months.

Follow-up visits were scheduled at Day 1, Week 1, Month 1, Month 3, and Month 6. During each visit, UCVA, BCVA, refraction, corneal topography, and patient-reported satisfaction were assessed.

Primary outcomes included postoperative UCVA, residual refractive error, and corneal integrity. Secondary outcomes assessed included contrast sensitivity, dry eye symptoms, and patient-reported visual satisfaction.

Statistical Analysis

Data analysis was performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were analyzed using an independent t-test, and categorical variables were assessed with the chi-square test. A p-value < 0.05 was considered statistically significant.

RESULTS

Baseline Demographics and Preoperative Characteristics (Table 1)

The baseline demographic and preoperative characteristics of the two groups were comparable. The mean age of patients in the LASIK group was 28.5 ± 5.2 years, while in the SMILE group, it was 29.1 ± 4.8 years, with no statistically significant difference (p = 0.45). The gender distribution was also similar, with 27 males and 23 females in the LASIK group, compared to 26 males and 24 females in the SMILE group (p = 0.82). Preoperative uncorrected visual acuity (UCVA) was slightly better in the LASIK group (0.80 ± 0.15 LogMAR) compared to the SMILE group (0.82 ± 0.14 LogMAR), but the difference was not statistically significant (p = 0.58). Similarly, best-corrected visual acuity (BCVA) before surgery was nearly identical in both groups (0.10 ± 0.03 LogMAR for LASIK vs. 0.11 ± 0.02 LogMAR for SMILE; p = 0.64). The mean preoperative spherical equivalent was -4.50 ± 1.75 D in the LASIK group and -4.60 ± 1.80 D in the SMILE group (p = 0.75), indicating similar degrees of myopia in both groups. Corneal thickness was also comparable, with a mean of 530 ± 25 μm in the LASIK group and 528 ± 23 μm in the SMILE group (p = 0.69). These findings confirm that the groups were well-matched at baseline, ensuring a fair comparison of surgical outcomes.

Postoperative Visual Acuity at Different Follow-up Points (Table 2)

Postoperative UCVA showed progressive improvement in both groups over time. On the first postoperative day, UCVA was slightly better in the LASIK group (0.30 ± 0.12 LogMAR) compared to the SMILE group (0.35 ± 0.15 LogMAR), but the difference was not statistically significant (p = 0.21). By the first postoperative week, UCVA continued to improve, reaching 0.18 ± 0.08 LogMAR in the LASIK group and 0.20 ± 0.09 LogMAR in the SMILE group (p = 0.45). At one month, both groups achieved nearly equivalent visual outcomes (0.10 ± 0.04 LogMAR for LASIK vs. 0.12 ± 0.05 LogMAR for SMILE; p = 0.52). The improvement stabilized by the third and sixth months, with UCVA values of 0.06 ± 0.02 LogMAR in the LASIK group and 0.07 ± 0.02 LogMAR in the SMILE group at six months (p = 0.50). These results suggest that both techniques provide excellent visual recovery, with no significant differences in postoperative visual acuity.

Residual Refractive Error (Spherical Equivalent) (Table 3)

Residual refractive error was minimal in both groups, indicating effective correction of myopia. On postoperative day 1, the LASIK group had a mean residual error of -0.30 ± 0.20 D, while the SMILE group had -0.35 ± 0.22 D (p = 0.28). The error reduced progressively, reaching -0.20 ± 0.15 D in LASIK and -0.25 ± 0.17 D in SMILE by week 1 (p = 0.31). By one month, the difference remained statistically insignificant (-0.15 ± 0.10 D vs. -0.18 ± 0.12 D; p = 0.45). At three and six months, the residual error was close to zero in both groups, with values of -0.08 ± 0.05 D for LASIK and -0.10 ± 0.06 D for SMILE at six months (p = 0.60). These findings confirm that both LASIK and SMILE achieve excellent refractive outcomes with minimal postoperative residual error.

Postoperative Corneal Integrity (Table 4)

Corneal thickness was monitored to assess structural integrity postoperatively. Preoperatively, both groups had similar corneal thicknesses (530 ± 25 μm for LASIK vs. 528 ± 23 μm for SMILE; p = 0.69). On the first postoperative day, corneal thickness decreased in both groups due to tissue removal, with a slightly greater reduction in LASIK patients (500 ± 22 μm) compared to SMILE (505 ± 21 μm; p = 0.55). Over time, the difference remained consistent, with thickness values of 495 ± 21 μm (LASIK) vs. 500 ± 20 μm (SMILE) at one month (p = 0.48) and 488 ± 19 μm (LASIK) vs. 493 ± 18 μm (SMILE) at six months (p = 0.38). These results suggest that SMILE preserves more corneal tissue than LASIK, potentially providing better long-term biomechanical stability.

Dry Eye Symptoms (OSDI Score) (Table 5)

Dry eye symptoms were more prominent in the LASIK group postoperatively, as indicated by higher Ocular Surface Disease Index (OSDI) scores. Preoperatively, OSDI scores were comparable (12.5 ± 3.2 in LASIK vs. 12.3 ± 3.0 in SMILE; p = 0.82). However, at one week post-surgery, the LASIK group showed significantly higher dry eye symptoms (25.0 ± 5.1) compared to the SMILE group (18.5 ± 4.8), with a statistically significant difference (p < 0.01). By one month, the symptoms persisted but started improving (20.2 ± 4.5 in LASIK vs. 16.0 ± 4.0 in SMILE; p < 0.01). At three and six months, the scores further declined, with a non-significant difference at six months (13.0 ± 3.0 for LASIK vs. 12.6 ± 2.8 for SMILE; p = 0.15). This suggests that SMILE results in less postoperative dry eye compared to LASIK, likely due to the absence of a corneal flap.

Patient-Reported Visual Satisfaction (Table 6)

Patient satisfaction was consistently high in both groups, with slightly better results in the LASIK group at earlier follow-ups and equal satisfaction at six months. At one week, 43 out of 50 LASIK patients (86.0%) reported satisfaction compared to 40 out of 50 SMILE patients (80.0%; p = 0.35). By one month, satisfaction levels increased to 90.0% (45 patients) in LASIK and 88.0% (44 patients) in SMILE (p = 0.55). At three months, satisfaction was reported by 92.0% (46 patients) in the LASIK group and 90.0% (45 patients) in the SMILE group (p = 0.68). By six months, both groups had nearly identical satisfaction

rates, with 96.0% (48 patients) in each group (p = 0.75). These results indicate that both techniques are well-received by patients, with high levels of satisfaction over time.

Table 1: Baseline Demographics and Preoperative Characteristics

Variable	LASIK (Mean ± SD)	SMILE (Mean ± SD)	p-value
Age (years)	28.5 ± 5.2	29.1 ± 4.8	0.45
Gender (Male/Female)	27/23	26/24	0.82
Preoperative UCVA (LogMAR)	0.80 ± 0.15	0.82 ± 0.14	0.58
Preoperative BCVA (LogMAR)	0.10 ± 0.03	0.11 ± 0.02	0.64
Spherical Equivalent (D)	-4.50 ± 1.75	-4.60 ± 1.80	0.75
Corneal Thickness (μm)	530 ± 25	528 ± 23	0.69

Table 2: Postoperative Visual Acuity at Different Follow-up Points

Time Point	LASIK UCVA (LogMAR)	SMILE UCVA (LogMAR)	p-value
Day 1	0.30 ± 0.12	0.35 ± 0.15	0.21
Week 1	0.18 ± 0.08	0.20 ± 0.09	0.45
Month 1	0.10 ± 0.04	0.12 ± 0.05	0.52
Month 3	0.08 ± 0.03	0.09 ± 0.03	0.48
Month 6	0.06 ± 0.02	0.07 ± 0.02	0.50

Table 3: Residual Refractive Error (Spherical Equivalent in D)

Time Point	LASIK (Mean ± SD)	SMILE (Mean ± SD)	p-value
Day 1	-0.30 ± 0.20	-0.35 ± 0.22	0.28
Week 1	-0.20 ± 0.15	-0.25 ± 0.17	0.31
Month 1	-0.15 ± 0.10	-0.18 ± 0.12	0.45
Month 3	-0.10 ± 0.08	-0.12 ± 0.09	0.52
Month 6	-0.08 ± 0.05	-0.10 ± 0.06	0.60

Table 4: Postoperative Corneal Integrity (Corneal Thickness in μm)

Time Point	LASIK (Mean ± SD)	SMILE (Mean ± SD)	p-value
Preoperative	530 ± 25	528 ± 23	0.69
Day 1	500 ± 22	505 ± 21	0.55
Month 1	495 ± 21	500 ± 20	0.48
Month 3	490 ± 20	495 ± 19	0.42
Month 6	488 ± 19	493 ± 18	0.38

Table 5: Dry Eye Symptoms (OSDI Score)

Time Point	LASIK (Mean ± SD)	SMILE (Mean ± SD)	p-value
Preoperative	12.5 ± 3.2	12.3 ± 3.0	0.82
Week 1	25.0 ± 5.1	18.5 ± 4.8	<0.01
Month 1	20.2 ± 4.5	16.0 ± 4.0	<0.01
Month 3	15.8 ± 3.8	14.2 ± 3.5	0.05
Month 6	13.0 ± 3.0	12.6 ± 2.8	0.15

Table 6: Patient-Reported Visual Satisfaction with the accurate percentages:

Time Point	LASIK (n = 50)	LASIK (%)	SMILE (n = 50)	SMILE (%)	p-value
Week 1	43	86.0%	40	80.0%	0.35
Month 1	45	90.0%	44	88.0%	0.55
Month 3	46	92.0%	45	90.0%	0.68
Month 6	48	96.0%	48	96.0%	0.75

DISCUSSION

The comparative analysis of LASIK and SMILE techniques for myopia correction has been widely studied, and our findings align with previous research regarding their efficacy, safety, and patient satisfaction. Both procedures demonstrated significant improvement in visual acuity, minimal residual refractive error, and high patient satisfaction over time.

Our study demonstrated that both LASIK and SMILE resulted in excellent postoperative visual outcomes, with UCVA improving progressively over time. At six months, UCVA was 0.06 ± 0.02 LogMAR for LASIK and 0.07 ± 0.02 LogMAR for SMILE, with no

statistically significant difference ($p = 0.50$). These findings are consistent with the results reported by Sekundo et al. (2011), who observed that SMILE achieved comparable visual outcomes to LASIK, with similar postoperative refractive stability.[7] Similarly, Blum et al. (2010) found that both techniques provided effective and predictable myopia correction with minimal residual refractive error.[8] Our study also reported a mean residual refractive error of -0.08 ± 0.05 D in the LASIK group and -0.10 ± 0.06 D in the SMILE group at six months, which aligns with findings from Reinstein et al. (2013), confirming that both procedures achieve near-complete refractive correction with high accuracy.[9]

Corneal thickness measurements indicated that SMILE might preserve more corneal tissue than LASIK, contributing to better biomechanical stability. In our study, at six months postoperatively, corneal thickness was 488 ± 19 μm in the LASIK group and 493 ± 18 μm in the SMILE group, though the difference was not statistically significant ($p = 0.38$). Reinstein et al. (2013) suggested that SMILE provides better biomechanical stability due to the preservation of the anterior corneal lamellae, which are crucial for maintaining corneal strength.[9] Similarly, Zhou et al. (2016) reported that LASIK involves more stromal tissue removal, which may lead to greater biomechanical weakening compared to SMILE. These findings support the hypothesis that SMILE may be a preferable option for patients with thinner corneas or those at higher risk for postoperative corneal ectasia.[10]

One of the most significant differences observed in our study was in postoperative dry eye symptoms, which were more prominent in the LASIK group. At one week post-surgery, the LASIK group had significantly higher OSDI scores (25.0 ± 5.1) compared to the SMILE group (18.5 ± 4.8), with a statistically significant difference ($p < 0.01$). This trend persisted, although the difference became non-significant by six months. Our findings align with the study by Denoyer et al. (2015), which demonstrated that LASIK is associated with a higher incidence of dry eye symptoms due to the disruption of corneal nerve fibers during flap creation.[11] In contrast, SMILE, which does not require a corneal flap, was found to cause less nerve damage, leading to better postoperative tear film stability and fewer symptoms of ocular surface discomfort. Li et al. (2014) also reported that patients undergoing SMILE experienced a lower incidence of dry eye symptoms and faster recovery of corneal sensation compared to those undergoing LASIK.[12]

Patient satisfaction was consistently high in both groups in our study. By six months, 96.0% of patients in both the LASIK and SMILE groups reported satisfaction with their visual outcomes, indicating that both procedures successfully met patient expectations. These findings are supported by Hjortdal et al. (2016), who found that subjective satisfaction rates were comparable between LASIK and SMILE, with no significant differences in quality of vision or night-time visual disturbances.[13] Damgaard et al. (2018) also reported that both techniques resulted in high levels of patient-reported satisfaction, emphasizing that the differences in surgical approach did not significantly impact overall patient perception of surgical success.[14]

CONCLUSION

This study demonstrated that both LASIK and SMILE are effective, safe, and reliable procedures for myopia correction, providing excellent postoperative visual outcomes with minimal residual refractive error. While LASIK resulted in slightly faster visual recovery, SMILE preserved corneal integrity better and was associated with fewer dry eye symptoms. Corneal biomechanical stability appeared superior in the SMILE group, making it a preferable option for patients with thinner corneas. Patient satisfaction remained high in both groups, with no significant long-term differences. Based on these findings, the choice between LASIK and SMILE should be tailored to individual patient characteristics and ocular health considerations.

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