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Clinical outcomes of small incision lenticule extraction versus advanced surface ablation in low myopia

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Abstract

Purpose: To compare the visual and refractive outcomes of small incision lenticule extraction and advanced surface ablation for low myopia or myopic astigmatism.

Methods: Retrospective, observational case series of our first 50 consecutive small incision lenticule extraction patients compared to refraction-matched 50 advanced surface ablation treatments with attempted spherical equivalent correction ⩽−3.5 D, astigmatism ⩽−1.5 D, and corrected distance visual acuity of 1.0 (decimal scale) or better. Only one eye per patient was included.

Results: Small incision lenticule extraction: mean attempted spherical equivalent correction was −2.80 ± 0.63 D. Uncorrected distance visual acuity was 0.85 and 1.0 at days 1 and 5, respectively. At 3 months, mean spherical equivalent refraction was 0.02 ± 0.32 D (range: −0.5 to +0.75 D), mean cylinder was −0.24 ± 0.21 D (range: 0 to −0.75 D), mean uncorrected distance visual acuity was 1.27, mean efficacy index was 0.96, and mean safety index was 1.05. Uncorrected distance visual acuity was same or better than corrected distance visual acuity in 96%, astigmatism ⩽0.5 D in 98% and ⩽1 D in 100% of eyes, respectively. Advanced surface ablation: mean attempted spherical equivalent correction was −2.75 ± 0.5 D. Uncorrected distance visual acuity was 0.72 and 0.61 at days 1 and 5, respectively. At 3 months, mean spherical equivalent refraction was 0.22 ± 0.32 D, mean cylinder was −0.27 ± 0.27 D, mean uncorrected distance visual acuity was 1.21, mean efficacy index was 1.03, and mean safety index was 1.08.

Conclusion: Small incision lenticule extraction for low myopia was found to be safe and effective with outcomes at 3 months similar to those obtained with advanced surface ablation while offering a quicker visual recovery.

Keywords

Small incision lenticule extraction, advanced surface ablation, low myopia

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Introduction

A new treatment modality called small incision lenticule extraction (SMILE) employs only a femtosecond laser for vision correction by removing stromal tissue from the cornea through a small side cut.[1,2] Many studies have shown good predictability and safety of SMILE especially in moderate myopia.[1,3–6]

Eyes with low myopia may be eligible for full correction with SMILE, too. However, SMILE for treating low myopia is still controversial, because there might be more cross-talk between the laser pulses at the anterior and posterior circumferences of the stromal lenticule, which may lead to incomplete tissue separation. Furthermore, the thin lenticule in low myopic corrections as opposed to thicker lenticules in higher corrections might set for a challenging lenticule separation and extraction by the surgeon as the tissue is prone to tear.

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Therefore, SMILE is not recommended for correcting myopia (including astigmatism) of <-3 diopter (D) in Germany,[7] and studies specifically evaluating low myopic treatments are scarce.[8–10]

The aim of this study was to report outcomes of SMILE in low myopic eyes with or without astigmatism and to compare these results to our advanced surface ablation (ASA) treatments.

Patients and methods

This observational case series comprises our first 50 consecutive patients treated with SMILE for the correction of low myopia or low myopic astigmatism. All SMILE procedures were performed between April 2015 and April 2017 and were compared to 50 matched eyes treated with ASA. In the SMILE group, only right eyes were included. Every SMILE eye was matched to one ASA-treated eye from our database with a maximum difference of ± 0.5 D in sphere and cylinder, respectively.

Inclusion criteria were an attempted manifest spherical equivalent (SE) correction up to -3.5 D, astigmatism up to 1.5 D, and a corrected distance visual acuity (CDVA) of 1.0 (decimal scale) or better. Refractive stability of ± 0.5 D SE over at least the last 12 months had to be documented.

Exclusion criteria for this study, in addition to other commonly accepted contraindications to refractive corneal surgery, included a myopic target refraction, a history or slit lamp signs of ocular trauma or ocular surgery and systemic use of corticosteroid, antimetabolite, or immunosuppressant agents. Patients with a history of recurrent basement membrane dystrophy or recurrent erosion syndrome were also excluded.

All patients provided informed consent before surgery and gave written consent to anonymous collection of their data for scientific analysis, as required by the local ethics committee. The study was performed in accordance with the ethical standards in the 1964 Declaration of Helsinki.

Preoperative assessment

Adult patients seeking vision correction were counseled about their surgical options during the preoperative examination and chose their preferred treatment modality without randomization. Allocation was not based on corneal pachymetry or on other anatomical parameters.

Wearing soft contact lenses was discontinued at least 2 weeks and rigid contact lenses at least 4 weeks before the initial examination. Preoperative evaluation included uncorrected distance visual acuity (UDVA, decimal scale), subjective refraction, CDVA (decimal scale), low-contrast visual acuity, stereoscopic depth perception (Stereo Test), slit lamp biomicroscopy, anterior segment evaluation using the Orbscan IIz (Bausch & Lomb Technolas, Munich, Germany) and the Pentacam AXL (Oculus Optikgeräte, Wetzlar, Germany), wavefront aberrometry (Zywave; Bausch & Lomb Technolas, Munich, Germany), dim-light pupillometry (Zywave; Bausch & Lomb Technolas, Munich, Germany), anterior segment optical coherence tomography (Avanti; Optovue, Fremont, CA, USA), endothelial microscopy (SP 3000P; Topcon Medical Systems, Oakland, NJ, USA), intraocular pressure measurement (Rebound-Tonometer, Ta-01; Icare, Vantaa, Finland), and dilated fundus evaluation. Automated refraction before and after pharmacologic pupil dilation was obtained (Canon R-F10; Canon Inc., Tokyo, Japan). Cycloplegic refraction using cyclopentolate was obtained in all patients younger than 30 years. The manifest refraction was performed at the initial visit and repeated at least at one separate visit before the surgery to determine the final refraction to plan the treatment.

Treatment planning

No nomogram adjustment was applied to neither the spherical nor the cylindrical components of the attempted refractive correction with SMILE. In contrast, our ASA treatments were performed with a 105% sphere adjustment based on our prior results. The postoperative target sphere was hyperopic for all patients younger than 30 years: $+0.25$ D between 22 and 29 years and $+0.5$ D between 18 and 21 years.

Surgical technique

All treatments were performed by the same surgeon (S.T.). All patients received a single tablet of bromazepam 6 mg (F. Hoffmann-La Roche AG, Basel, Switzerland) to minimize intraoperative anxiety.

SMILE

Immediately before surgery, the eyelids were draped in a sterile fashion. Topical anesthesia was achieved with one drop of unpreserved oxybuprocainhydrochlorid (Conjucain EDO; Dr. Mann Pharma, Berlin, Germany). All SMILE procedures were performed with the VisuMax 500-kHz femtosecond laser (Carl Zeiss Meditec, Jena, Germany) with the software version 3.0 as described in detail previously elsewhere.[11]

The small size contact glass was used for all eyes. The cap thickness used was 120 µm in all eyes. To maximize the ease of separating the anterior and posterior planes of the lenticule, during the first 18 cases, the thickness of the lenticule was deliberately increased by raising the default minimum lenticule thickness (lenticule side cut) from 15 to 20 µm in three eyes, to 25 µm in one eye, and to 30 µm in five eyes, respectively. Thereafter, the refractively neutral minimum lenticule thickness was kept at the default

setting (15 µm), and instead, the lenticule diameter was enlarged to 7.0 mm to increase the thickness of the lenticule, in order to give a better optical quality with the same amount of removed tissue.

The incision was opened and the upper and lower planes of the lenticule edge were delineated. The upper interface was separated first using a dedicated semi-sharp spoon shaped dissector (6-836-1; Duckworth & Kent Ltd, Herts, England). The lower lenticular interface was then separated in a similar fashion. Once both planes had been separated, the lenticule was removed from the cornea by extracting the lenticule through the small incision. The lenticule was then hydrated with a milky prednisolone acetate suspension (Inflanefran forte; Allergan Pharm., Westport, Ireland) on the corneal surface to distend it for visual inspection for completeness and edge smoothness. The same milky solution was used to check the side cut after full central distension of the cap was achieved by centrifugal stroking using a moist non-fragmenting microsponge to ensure that any redundant cap was redistributed to the periphery.

ASA

Approximately 30 min before surgery, one drop of proxymetacainhydrochlorid (Proparakain-POS; Ursapharm, Saarbrücken, Germany) and one drop of unpreserved ofloxacin eye drops (Floxal EDO; Dr. Mann Pharma, Berlin, Germany) were instilled in the eyes. Immediately before surgery, the eyelids were disinfected with povidone-iodine 10% (Betaisodona; Mundipharma, Limburg, Germany) and draped in a sterile fashion. Topical anesthesia was achieved with several drops of proxymetacainhydrochlorid. A speculum with suction was placed in the operative eye. Ice-cool physiologic saline solution was administered for 30 s to cool the ocular surface and reduce postoperative pain perception. An epithelial defect with a standardized diameter was typically obtained as follows: a Vidaurri Fluid Retention Ring (Katena; Denville, NY, USA) with an 8.7 mm inner diameter was placed on the cornea and filled with 18% ethanol for 30 s. Then, the ethanol was absorbed using a dry non-fragmenting sponge, and the ocular surface was rinsed again with cooled saline solution. The loosened epithelium was then peeled back using a dedicated epithelial rake and a blunt spatula. The epithelial flap was completely removed. The underlying stromal bed was ablated with an excimer laser (217 Z 100 P, software version 5.0, Bausch & Lomb Technolas, Berlin, Germany) using an aspheric ablation profile. Then, ice-cooled saline solution was again applied for approximately 30 s. Due to the comparatively low amount of planned ablation depth mitomycin-C (MMC) 0.02% for 15 s was only used in a single eye with an ablation depth of >100 µm to prevent haze and scar formation.

A bandage soft contact lens (Acuvue Oasys; diameter: 14.0 mm, base curve 8.6 mm, and optical power: 0 D Johnson & Johnson, New Brunswick, New Jersey) was then placed over the cornea. One drop of prednisolone acetate (Inflanefran forte; Allergan Pharm., Westport, Ireland) and one drop of ofloxacin were applied at the end of surgery.

Postoperative protocol

All patients were advised to use unpreserved artificial tear drops (hyaluronic acid) hourly for 1–2 weeks and then to taper over 3 months.

After SMILE, unpreserved ofloxacin and unpreserved dexamethasone (Dexa EDO; Dr. Mann Pharma, Berlin, Germany) eye drops were prescribed four times a day for 5 days.

After ASA, unpreserved ofloxacin eye drops were prescribed four times a day for 5 days and continued until epithelial closure, if needed. Fluorometholone (Fluoropos; Ursapharm, Saarbrücken, Germany) eye drops were prescribed four times a day and tapered every 3 weeks (total 12 weeks). Oral analgesics (Novaminsulfon; Rathiopharm, Ulm, Germany) were prescribed to be taken as needed to reduce pain perception.

Follow-up visits

Postoperative follow-up visits were scheduled at day 1, day 5, and 3 months. If required, additional examinations were added. Further examinations by the referring ophthalmologist were not evaluated in this study. Slit lamp examination including haze grading was performed by the surgeon without prior access to the patient's chart. We report haze levels based on the Fantes classification (0: normal, 0.5: possible to observe opacity under indirect light, 1: possible to observe opacity under direct light, 2: possible to observe iris in detail, 3: difficult to observe iris in detail, and 4: impossible to observe iris in detail).[12]

Statistical analysis

Outcome analysis was performed according to the Standard Graphs for Reporting Refractive Surgery.[13–15] The outcomes were analyzed for the primary treatment data. All eyes were included for intraoperative and postoperative complications analysis. Statistical analysis was performed with SPSS for Mac (SPSS 20; IBM Corporation, New York, NY, USA). Parameters were tested for Gaussian-distribution using the Kolmogorov–Smirnov test. A non-parametric Mann–Whitney U test was performed to test for differences in distribution between preoperative and postoperative visual acuities, efficacy, and safety, respectively. A p value <0.05 was considered statistically significant. All continuous values are expressed as mean ± standard deviation (SD), if not denoted otherwise.

Table 1. Demographic and refractive data.

Characteristics	SMILE	ASA	*p* value
	Total ($n=50$, $N=50$)	Total ($n=50$, $N=50$)	
Gender (female/male)	25/25	28/22	
Age (years)	median 34 (range: 21 to 61)	median 29 (range: 19 to 52)	0.029*
CDVA	1.34 (range: 1.0 to 2.0)	1.2 (range: 1.0 to 2.0)	<0.001*
Preoperative SE refraction (D)	−2.75 ± 0.63 (range: −1.25 to −3.5)	−2.61 ± 0.54 (range: −1.25 to −3.5)	0.013*
Attempted SE refraction correction (D)	−2.80 ± 0.63 (range: −1.25 to −3.5)	−2.75 ± 0.54 (range: −1.63 to −3.5)	0.383
Preoperative refractive astigmatism (D)	−0.56 ± 0.39 (range: 0 to −1.5)	−0.55 ± 0.44 (range: 0 to −1.5)	0.647
Preoperative corneal thickness (µm)	560 ± 35 (range: 486 to 663)	550 ± 40 (range: 451 to 618)	0.563
SMILE cap thickness (µm)	120	n/a	
SMILE minimum lenticule thickness (µm)	17 ± 5 (15 in 82%, 20 in 6%, 25 in 2%, and 30 in 10%)	n/a	
SMILE maximum lenticule thickness/ ASA maximum ablation depth (µm)	70 ± 9.4 (range: 50 to 92)	68 ± 13 (range: 43 to 102)	0.173
Optical zone (mm)	6.7 ± 0.3 (6.2 in 2%, 6.5 in 50%, 6.8 in 4%, and 7.0 in 44%)	6.5	

SMILE: small incision lenticule extraction; ASA: advanced surface ablation; CDVA: corrected distance visual acuity; SE: spherical equivalent; D: diopter; n/a: not applicable.
* statistically significant ($p<0.05$).

Table 2. UDVA over time in logMAR notation (mean ± SD).

	Preoperative	Day 1	Day 5	3 months
SMILE	−0.12 ± 0.07	0.10 ± 0.17	0.0 ± 0.14	−0.09 ± 0.11
ASA	−0.07 ± 0.07	0.33 ± 0.22	0.28 ± 0.21	−0.08 ± 0.08

UDVA: uncorrected distance visual acuity; logMAR: logarithm of the minimum angle of resolution; SD: standard deviation; SMILE: small incision lenticule extraction; ASA: advanced surface ablation

Although the logarithm of minimum angle of resolution (logMAR) values of all visual acuity tests were used for statistical analyses, we converted them to the Snellen quotation (decimal scale) throughout the text.

Results

The treatment data and baseline characteristics are shown in Table 1.

Visual acuity and refractive outcome

SMILE

Mean UDVA was 0.85 and 1.0 at days 1 and 5, respectively. After 3 months, mean UDVA was 1.27 (range: 0.63–2.0) and the efficacy index (postoperative UDVA/preoperative CDVA) was 0.96. Table 2 shows UDVA over time after SMILE and ASA, respectively.

Figure 1 shows the Standard Graphs for Reporting Refractive Surgery 3 months after SMILE. UDVA was 1.0 or better in 88% and 0.80 or better in 98% of eyes, respectively (Figure 1(a)). UDVA was within one line of CDVA in 98% of all eyes (Figure 1(b)). Mean CDVA was 1.39 (range: 0.8–2.0) for all eyes. Safety index (postoperative CDVA/preoperative CDVA) of all eyes was 1.05. One eye lost one line and one eye lost two lines of CDVA, respectively (Figure 1(c)).

There was an excellent correlation of attempted and achieved SE refraction (Figure 1(d)). The difference of the mean achieved SE refraction to intended target was +0.04 ± 0.3 D (range: −0.75 to +0.5 D). Ninety-eight percent of all eyes were within ±0.5 D of intended SE refraction, and all eyes were within ±1 D, respectively (Figure 1(e)). Mean SE was stable from day 1 to 3 months (Figure 1(f)). However, 44% of all eyes displayed a change >0.5 D in this time frame.

Mean residual astigmatism was −0.24 ± 0.21 D (range: 0 to −0.75 D). Residual refractive astigmatism was ⩽0.5 D in 98% and ⩽1 D in 100% (Figure 1(g)). Mean surgically induced astigmatism (SIA) was equal to target-induced astigmatism (TIA) (Figure 1(h)).

The mean absolute refractive astigmatism angle of error was 0.1 ± 0.7° with 76% of all eyes displaying an absolute angle of error ⩽15° (Figure 1(i)). No eye was re-treated in the SMILE group.

ASA

Mean UDVA was 0.72 and 0.61 at days 1 and 5, respectively. After 3 months, mean UDVA was 1.21, range: 0.63−2.0, the efficacy index was 1.03, and mean safety index 1.08.

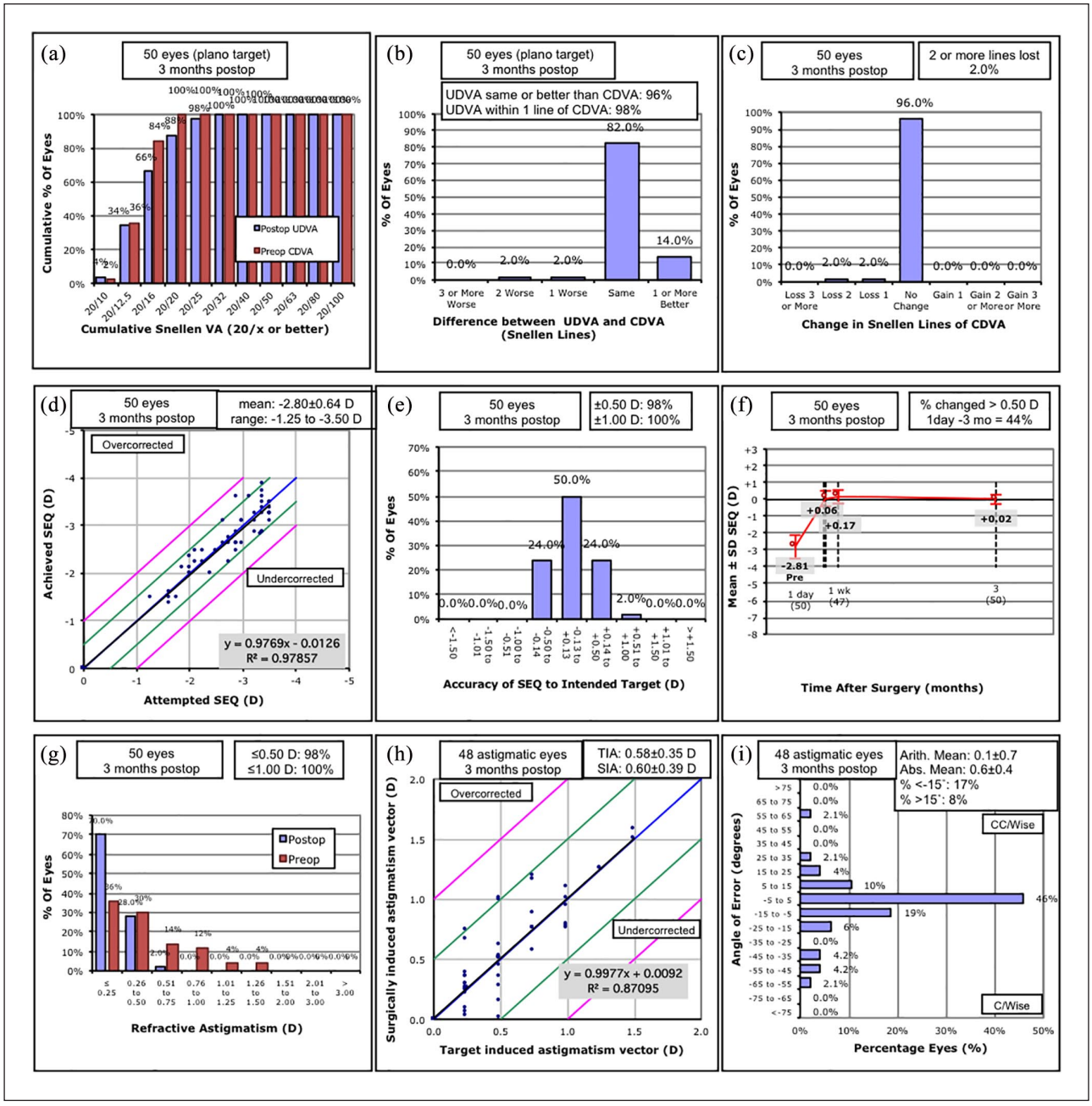

Figure 1. Standard Graphs for Reporting Refractive Surgery showing the visual and refractive outcomes 3 months after small incision lenticule extraction in 50 eyes with low myopia or myopic astigmatism: (a) uncorrected distance visual acuity, (b) uncorrected distance visual acuity versus corrected distance visual acuity, (c) change in corrected distance visual acuity, (d) spherical equivalent refraction attempted versus achieved, (e) spherical equivalent refraction accuracy, (f) spherical equivalent refraction stability, (g) refractive astigmatism, (h) target-induced astigmatism versus surgically induced astigmatism, and (i) refractive astigmatism angle of error.

Figure 2 shows the Standard Graphs for Reporting Refractive Surgery 3 months after ASA. UDVA was 1.0 or better in 94% of eyes and 0.80 or better in 98% of eyes, respectively (Figure 2(a)). UDVA was within one line of CDVA in 98% of all eyes (Figure 2(b)).

There was an excellent correlation of attempted and achieved SE refractions (Figure 2(d)). The difference of the mean SE refraction to intended target was -0.11 ± 0.32 D (range: -0.75 to $+0.5$ D). A total of 98% of all eyes were within ± 0.5 D of intended SE refraction and 100% were within ± 1 D, respectively (Figure 2(e)).

Mean residual astigmatism was -0.27 ± 0.27 D. Residual refractive astigmatism was $\leqslant 0.5$ D in 92%

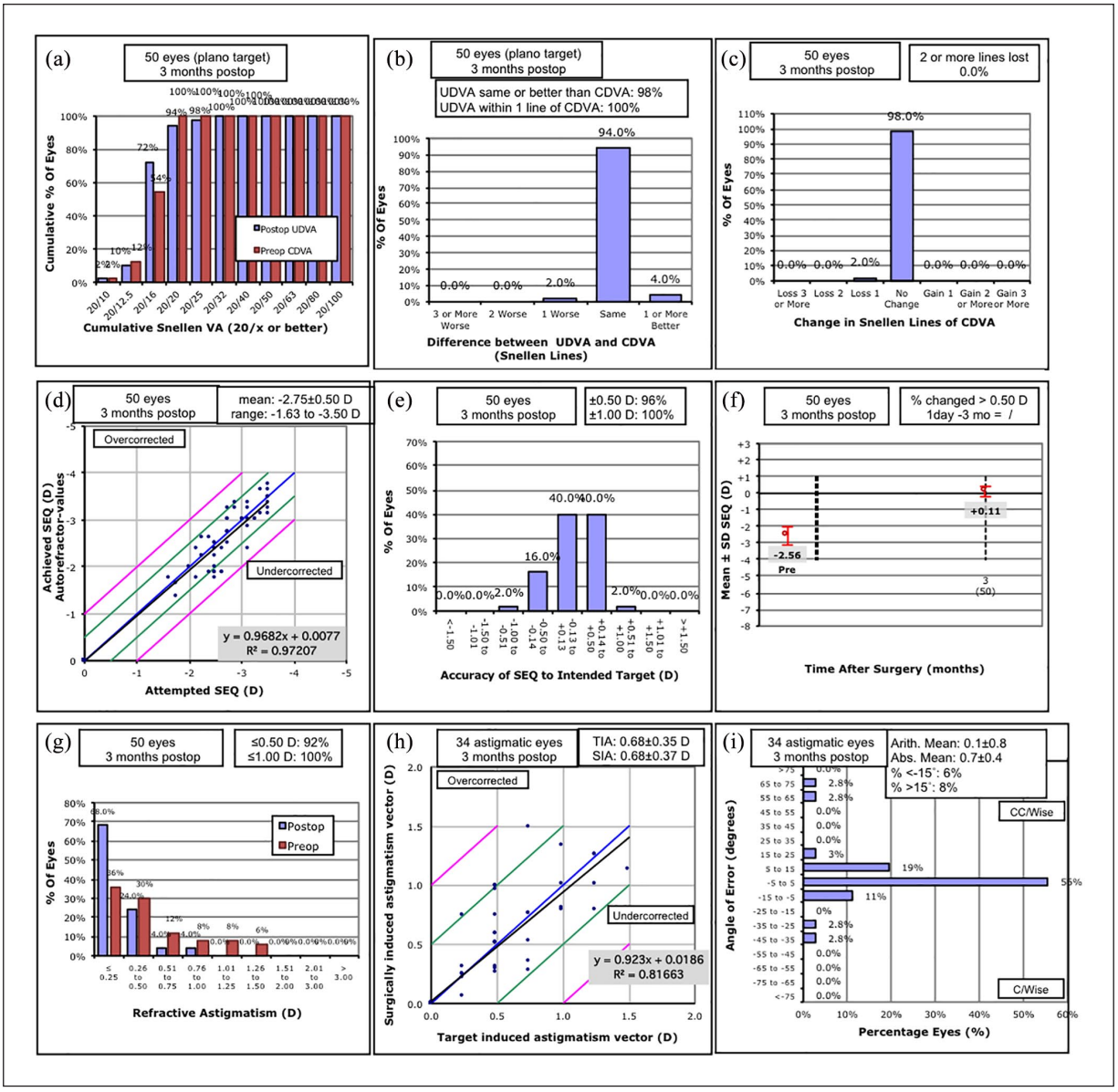

Figure 2. Standard Graphs for Reporting Refractive Surgery showing the visual and refractive outcomes 3 months after advanced surface ablation in 50 eyes with low myopia or myopic astigmatism: (a) uncorrected distance visual acuity, (b) uncorrected distance visual acuity versus corrected distance visual acuity, (c) change in corrected distance visual acuity, (d) spherical equivalent refraction attempted versus achieved, (e) spherical equivalent refraction accuracy, (f) spherical equivalent refraction stability, (g) refractive astigmatism, (h) target-induced astigmatism versus surgically induced astigmatism, and (i) refractive astigmatism angle of error.

and ⩽1 D in 100% (Figure 2(g)). Mean SIA and TIA were highly correlated ($R^2 = 0.82$, Figure 2(h)).

The mean absolute refractive astigmatism angle of error was 0.1 ± 0.87° with 85% of all 34 preoperatively astigmatic eyes displaying an absolute angle of error ⩽15° (Figure 2(i)). No eye was re-treated for residual ametropia after ASA.

Statistical comparison

At 3 months, UDVA ($p = 0.343$), the difference of the mean SE refraction to intended target ($p = 0.726$), efficacy index ($p = 0.177$), and safety index ($p = 0.345$) were not statistically different between the SMILE and ASA groups.

Complications

Table 3 summarizes intraoperative and postoperative complications.

Small epithelial defects at the SMILE incision typically required no special treatment and were completely healed on the following day. In one eye, the central epithelium was loosened but not disrupted when gently massaged

Table 3. Intraoperative and postoperative complications.

Parameter	SMILE (%)	ASA (%)
Intraoperative		
Epithelial defect at small incision (no BCL)	20	n/a
Loose epithelial cells centrally (BCL required)	2	n/a
Incision extension (<1 mm)	2	n/a
Suction loss	0	n/a
Incomplete lenticule extraction	0	n/a
Epithelial ingrowth	0	n/a
Epithelial cells in interface	0	n/a
Postoperative		
Superficial punctuate keratitis	6	2
Infection	0	0
Diffuse lamellar keratitis	0	0
Haze	*Interface haze*	*Subepithelial haze*
Trace haze	2	20
Haze 1	2	12
Haze 2 including central opacity	0	0

SMILE: small incision lenticule extraction; ASA: advanced surface ablation; BCL: bandage contact lens; n/a: not applicable.

with a moist sponge after extracting the lenticule. A bandage contact lens (BCL) was applied for 5 days. Visual acuity was low on the first postoperative day (UDVA: 0.32), but recovered fast after BCL removal (UDVA: 1.25, 2 weeks postoperative). During ASA treatments, no intraoperative complications occurred.

After SMILE, we observed no epithelial ingrowth or the inadvertent implantation of epithelial cells during lenticule preparation by the surgeon. The most common complication after ASA was trace haze without affecting visual acuity.

Discussion

SMILE has been shown to be safe and effective for correcting moderate myopia and myopic astigmatism.[1,3–5,16,17] However, only few studies deal with myopia <−3.5 D.[8–10,18] Potential issues in forming and separating a thin lenticule as required in these small corrections include limitations of the cutting accuracy of the femtosecond laser and possible cross-talk between both bubble layers due to their proximity, as well as a surgically more challenging tissue preparation ultimately leading to incomplete lenticule extraction. Therefore, we wanted to compare visual and refractive outcomes of SMILE to ASA, which has been our preferred treatment option, in low myopic corrections.

To avoid possible problems associated with a delicate thin lenticule, we increased the lenticule thickness deliberately by increasing the default side cut from 15 to 30 µm in our first cases of low myopic treatments. However, after that, we changed our strategy to increase the lenticule thickness and opted to increase the lenticule diameter. Thus, the optical zone was enlarged without sacrificing unnecessary tissue for an increased but still refractively neutral side cut.

In the present case series, we observed some minor intraoperative complications with SMILE as opposed to ASA. This may be explained by the more challenging surgical technique of SMILE and the difference in our personal experience with both treatment modalities. However, none of these complications was specifically linked to the small amount of attempted correction.

In the early postoperative period, we found a quicker visual recovery after SMILE than after ASA, as expected. In fact, visual recovery after these low myopic corrections was faster than after our higher corrections with SMILE (data currently under review). We may speculate that corneal edema is more intense with thicker lenticules leading to less cloudy vision with lower corrections.

At 3 months, our mean results after SMILE and ASA were clinically comparable. However, we observed less haze formation with SMILE than with ASA. Our rate of haze formation after ASA could potentially have been lower with the use of MMC. However, for the last few years, the "Kommission für Refraktive Chirurgie" (German Committee for Refractive Surgery) has discouraged the use of MMC in primary laser ablation for lack of evidence of effect. That is why we restricted our use of MMC since then. However, no patient felt disturbed by that level of haze, nor did we find clues that visual acuity was negatively affected.

Our visual and refractive outcomes after SMILE were equivalent to the weighted average of the four published studies reporting results after low myopic corrections (Table 4).

Reinstein et al.[8] found good refractive outcomes in low myopia after SMILE and reported no complications due to the delicate lenticule. Ganesh et al.,[9] who compared SMILE and photorefractive Keratectomy (PRK) for SE below −4 D in 60 eyes of 30 patients found significantly better visual results for SMILE in terms of safety, efficacy, and quality of vision.

Some surgeons prefer Laser-in-situ-Keratomileusis (LASIK) over ASA in moderate and even in low myopia as reported by Khalifa et al.[19] They prospectively evaluated SMILE and wavefront-guided LASIK for −6 D or less of myopia and found results favoring wavefront-guided LASIK. However, this is beyond the scope of this article.

This study has limitations due to its retrospective nature as it is non-randomized and compares two different groups of patients rather than comparing both surgical techniques intra-individually. Therefore, some confounding factors cannot be ruled out. Another limitation of our study is the limited follow-up of 3 months as haze and refractive outliers after ASA may decrease, on one hand, and visual and

Table 4. Overview of SMILE results for low myopic correction in the literature in comparison to the present SMILE study.

First author	Description	Laser/profile	Number of eyes	Follow-up time	Inclusion criteria	Mean preoperative refraction	Accuracy			UDVA			Efficacy index	Safety		
							Mean postoperative refraction	±0.5 D (%)	±1 D (%)	Pre-CDVA 20/20 or better (%)	20/20 or better (%)	20/25 or better (%)		One line (%)	Two lines (%)	Safety index
Fernández et al.[18]	To determine safety, efficacy, and predictability of SMILE	VisuMax 500-kHz femtosecond laser	30 (30 patients)	6 months	Myopia −1 to −3 D, CDVA ⩾ 20/25	SE −2.07 ± 0.58 D (range: −1 to −3 D); sphere, n/r; cylinder, n/r	SE −0.2 ± 0.37 D (range: 0.25 to −1.63 D); sphere, n/r; cylinder, n/r	87	97	100	67	97	–	3.3	–	–
Reinstein et al.[8]	Visual and refractive outcomes of SMILE for low myopia	VisuMax 500-kHz femtosecond laser	110 (69 patients)	1 year	Attempted SE ⩽ −3.5 D; cylinder ⩽ −1.5 D; CDVA ⩾ 20/20	SE −2.61 ± 0.54 D (range: −1.03 to −3.5 D); sphere, n/r; cylinder −0.55 ± 0.38 D (range: 0 to −1.5 D)	SE −0.05 ± 0.36 D (range: +1.25 to −0.94 D); sphere, n/r; cylinder −0.2 ± 0.22 D (range: 0 to −1 D)	84	99	100	96	100	–	9	0	–
Ganesh et al.[9]	Comparison of vision quality between SMILE and PRK	VisuMax 500-kHz femtosecond laser	60 (30 patients)	3 months	SE ⩽ −4 D; cylinder ⩽ −0.75 D	SE −3.08 ± 1.03 D; sphere −2.87 ± 1.03 D; cylinder −0.36 ± 0.36 D	SE −0.15 ± 0.19 D; sphere, n/r; cylinder, n/r	97	100	100	97	100	–	0	0	–
Torky and Alzafiri[10]	Evaluation of efficacy, predictability and stability of SMILE	VisuMax 500-kHz femtosecond laser	94	6 months	SE −1 to −3 D; CDVA ⩾ 20/25	SE −2.73 D (range: −1.5 to −2.87 D); sphere −2.25 D (range: −1.5 to −2.75 D); cylinder −0.25 D (range: 0 to −1.25 D)	SE 0 D (range: −0.87 to 0.37 D); sphere 0.25 D (range: −0.5 to 0.75 D); cylinder −0.5 D (range: 0 to −1 D)	89.3	100	100	90.4	n/r	0.94	0	0	1.02
Weighted average of the above studies			294	3–12 months		SE −2.69 D; sphere −2.49 D; cylinder −0.4 D	SE −0.07 D; sphere 0.25 D; cylinder −0.34 D	88.7	99.3	100	91.45	99.55	0.94	3.7	0	1.02
Present SMILE study	Correction of low myopia with SMILE	VisuMax 500-kHz femtosecond laser	50 (50 patients)	3 months	Attempted SE ⩽ −3.5 D; cylinder ⩽ −1.5 D; CDVA ⩾ 20/20	SE −2.75 ± 0.63 D (range: −1.25 to −3.5 D); sphere −2.47 ± 0.64 D (range: −1 to −3.25 D); cylinder −0.56 ± 0.42 D (range: 0 to −1.5 D)	SE 0.02 ± 0.28 D; sphere 0.14 ± 0.30 D; cylinder −0.24 ± 0.21 D	96	100	100	88	98	0.96	2	2	1.05

SMILE: small incision lenticule extraction; PRK: photorefractive Keratectomy; UDVA: uncorrected distance visual acuity; CDVA: corrected distance visual acuity; SE: spherical equivalent; D: diopter; n/r: not reported.

refractive results after SMILE may improve for more than 12 months. Therefore, a longer follow-up is needed to quantify long-term visual outcomes.

In conclusion, as our final results after SMILE and ASA were clinically equivalent, we now prefer SMILE over ASA for low myopia correction because it offers a more rapid visual recovery and less haze formation. However, ASA will remain an integral part of our armamentarium for special cases like corneal dystrophies, recurrent erosion syndrome, and thin corneas.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Drs S.T. and H.B.D. are consultants to Carl Zeiss Meditec (Jena, Germany) and Bausch & Lomb Technolas (Munich, Germany). No other author has a financial or proprietary interest in any material or method mentioned.

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