Femtosecond laser–assisted sutureless anterior lamellar keratoplasty for superficial corneal opacities

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PURPOSE: To evaluate the visual and refractive outcomes, endothelial cell count (ECC), ocular surface changes, corneal aberrations, and biomechanical profile changes after femtosecond laser–assisted anterior lamellar keratoplasty surgery for superficial corneal scars.

SETTING: Farabi Eye Hospital, Tehran University of Medical Sciences, Tehran, Iran.

DESIGN: Prospective case series.

METHODS: Patients with superficial corneal scars had femtosecond laser–assisted anterior lamellar keratoplasty. Visual and refractive results, ECC, ocular surface changes, corneal aberrations, and biomechanical profiles were assessed preoperatively and for 1 year postoperatively.

RESULTS: Nineteen eyes (19 patients) were evaluated. A significant decline occurred in refractive astigmatism and corneal astigmatism after 1 year. There was a nonsignificant reduction in corneal hysteresis and the corneal resistance factor from preoperatively to 1 year postoperatively. The corneal-compensated intraocular pressure (IOP) and Goldmann-correlated IOP increased during the follow-up; the increase was not significant. A statistically insignificant reduction in the root mean square for trefoil and spherical aberrations occurred between 1 month and 1 year postoperatively ($P = .1$ and $P = .4$, respectively). The decreases in primary coma and total higher-order aberrations approached significance ($P = .08$ and $P = .07$, respectively). There were no significant changes in the central corneal thickness, ECC, or ocular surface parameters. No intraoperative complications occurred.

CONCLUSION: Femtosecond laser–assisted anterior lamellar keratoplasty was an efficient and safe procedure for improving the quality of vision in patients with anterior corneal pathology, and the results remained stable during the 1-year follow-up.

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Online Video

For many years, the treatment of corneal scars has been considered challenging and penetrating keratoplasty (PKP) was regarded as a gold-standard treatment for these disorders. Anterior lamellar keratoplasty was then introduced to treat opacities confined to superficial layers of the cornea. Anterior lamellar keratoplasty is considered to have several advantages over PKP, including more rapid visual recovery, a lower rate of intraoperative complications, and a decreased risk for graft failure or rejection.[1,2] Moreover, the procedure potentially allows 1 donor to be used for 2 or more recipients, although the potential risk for infecting multiple hosts has reduced the use of this practice.[3] However, there are several drawbacks to anterior lamellar keratoplasty, such as the technical difficulties of manual dissection and the probability of stromal interface irregularities.[4,5]

Recently, the femtosecond laser was presented as a safe and effective modality for creating precise, highly reproducible corneal cuts and has been used

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successfully for laser in situ keratomileusis (LASIK) flaps, channel creation for intrastromal corneal ring segments, and donor and host preparation for anterior lamellar keratoplasty.[5] Precise cuts by the femtosecond laser are reported to obviate the need for suturing in anterior lamellar keratoplasty in patients with a residual stromal bed (RSB) thicker than 250 μm.[4–6] The sutureless technique in corneal grafting for anterior corneal haze using the femtosecond laser, first described by Yoo et al.,[4] reduces the duration of surgery and avoids suture-related problems. Later, Bonfadini et al.[7] reported 6 patients who had the same procedure, 3 of which had deeper scars. The RSB after anterior lamellar keratoplasty was 50 μm or 250 μm.

In this study, patients with anterior corneal opacities were comprehensively evaluated for several ocular parameters before and after the femtosecond laser–assisted sutureless anterior lamellar keratoplasty. The follow-up was 1 year.

PATIENTS AND METHODS

This study evaluated consecutive patients with superficial corneal scars secondary to a previous bout of infectious keratitis who were examined between March 2010 and September 2011. The study was approved by the Institutional Review Board, Tehran University of Medical Sciences, and complied with the tenets of the Declaration of Helsinki.

Excluded were patients with dense corneal scars to avoid complications of laser application through scarred tissue, corneal scars secondary to herpes simplex stromal keratitis because of the probable effect of herpes on the endothelium, scars involving the posterior 250 μm of cornea, significant vision improvement with contact lenses, and fewer than 12 months of follow-up.

Anterior segment optical coherence tomography (AS-OCT) (Visante, Carl Zeiss Meditec AG) was used for the preoperative estimation of the depth of the corneal scars. The uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), refraction, and keratometry (Pentacam Scheimpflug imaging system, Oculus Optikgeräte GmbH) were measured preoperatively and 1, 3, 6, and 12 months postoperatively. A dynamic bidirectional applanation device (Ocular Response Analyzer, Reichert Technologies) was used to measure the corneal biomechanical profile, including corneal hysteresis (CH), the corneal resistance factor (CRF), corneal-compensated intraocular pressure (IOPcc), and Goldmann-correlated IOP (IOPg). An experienced examiner performed consecutive measurements with the dynamic bidirectional applanation device in each eye. Only good-quality measurements with 2 distinct peaks were included in the study. Because topical corneal anesthesia can cause lower IOPcc readings,[8] the IOPcc measurements were taken first. The central corneal thickness (CCT) was measured with an ultrasonic pachymeter (SP3000, Tomey Corp.). The mean of 3 readings was recorded for CCT and the dynamic bidirectional applanation device parameters. In addition, at all postoperative visits, total wavefront analysis was performed through a 6.0 mm pupil using an iTrace aberrometer (Tracey Technologies) in a dark room. The endothelial cell count (ECC) was measured by specular microscopy (Konan Medical). The Scheimpflug imaging system was used to evaluate corneal astigmatism and keratometry. Dynamic bidirectional applanation measurements, pachymetry, specular microscopy, Scheimpflug imaging, and aberrometry were performed preoperatively and at all postoperative visits.

Tear osmolarity (osmometer, Tearlab Corp.), tear film breakup time (TBUT), and the Schirmer II test with anesthesia were evaluated at each visit. The TBUT was measured by the same expert examiner in all cases. After 3 μL of nonpreserved sodium fluorescein 2.0% were instilled on the bulbar conjunctiva, the patient was asked to blink naturally. After 15 seconds of the fluorescein instillation, the patient was asked to stare forward without blinking. Using cobalt-blue illumination, the duration between the last complete blink and the first appearance of growing micelle was calculated as the TBUT time.

The surgical technique used for the creation of donor and recipient corneal lenticules was according to a technique described by Yoo et al.[4] (Video 1, available at http://jcrsjournal.org). Femtosecond laser decagonal cuts were performed in the donor lenticule and recipient cornea using a Femtec femtosecond laser system (20/10 Perfect Vision AG). The donor lenticule thickness was 160 to 270 μm according to the lesion depth seen on AS-OCT, and the donor lenticule diameter was 7.5 to 8.2 mm. The donor lenticule was up to 20% thicker than the recipient to adjust for donor tissue edema. The recipient corneal lenticule was set to be 0.1 mm smaller in diameter than the donor graft diameter. The decagonal lenticule was placed on the recipient stromal bed; no sutures or glue were used. A bandage contact lens was applied to the cornea (Figure 1). In some cases with RSB scars, phototherapeutic keratectomy (PTK) was applied to smooth the stromal bed after the lamellar cut.

Statistical analysis was performed using SPSS software (version 11.0, SPSS, Inc.). Values are presented as the mean ± standard deviation. The UDVA and CDVA are presented in logMAR units. A P value less than 0.05 was considered statistically significant.

RESULTS

The study comprised 19 eyes of 19 patients. The mean age of the patients was 36 ± 7.1 years.

One month after surgery, there was a significant improvement in the UDVA ($P<.001$) and CDVA ($P=.01$) (Table 1). Refractive astigmatism and

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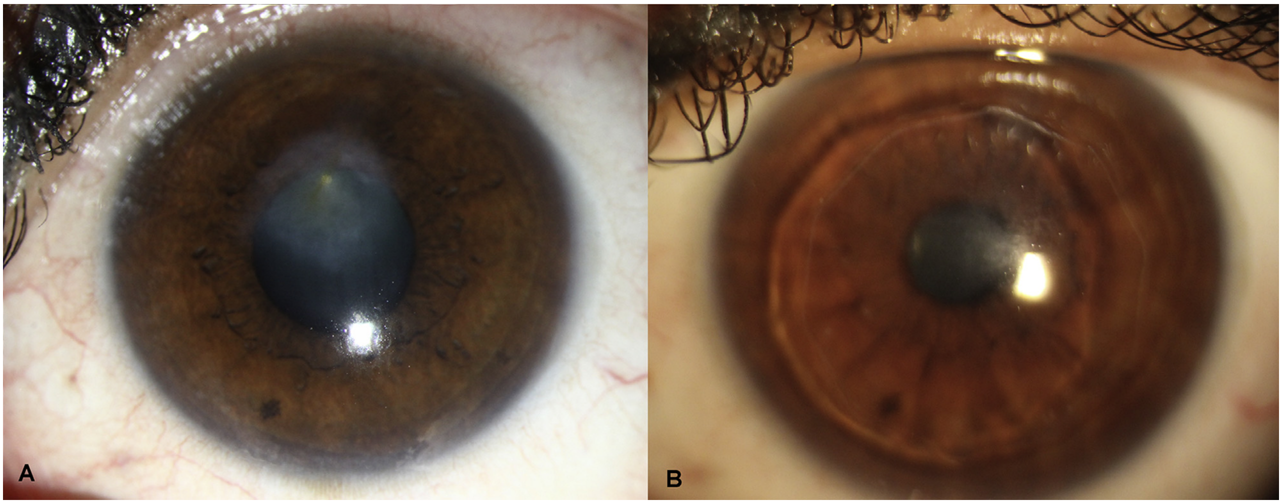

Figure 1. Preoperative (*A*) and 1-month postoperative (*B*) photographs of an eye with superficial haze.

corneal astigmatism (delta K) were significantly reduced after 1 year. There were no statistically significant differences in spherical equivalent (SE) or mean keratometry between preoperatively and the final visit.

There was a nonsignificant reduction in CH and the CRF from preoperatively to 1 year postoperatively. Postoperatively, the IOPcc and IOPg increased; however, the change was not statistically significant. In addition, the change in the CCT at the postoperative visits was not statistically significant, although the change from the preoperative value to 12 months postoperatively approached significance. The IOP increased from preoperatively; however, the difference was not statistically significant (Table 2).

During the 1-year follow-up, trefoil and spherical aberrations decreased; the changes were not statistically significant ($P = .1$ and $P = .4$, respectively). The decrease in primary coma and total higher-order aberrations (HOAs) approached significance ($P = .08$ and $P = .07$, respectively) (Table 3).

The preoperative endothelial cell density (ECD) could not be assessed in 6 eyes (31.6%) because of corneal scarring. The cell loss was 0.5% between preoperatively and 1 month postoperatively; the decrease was not statistically significant ($P = .09$).

Table 1. Visual, refractive, and ocular surface indices over time.

	Mean ± SD					
		Postoperative				
Parameter	Preoperative	1 Month	3 Months	6 Months	12 Months	*P* Value*
UDVA (LogMAR)	1.03 ± 0.32	0.42 ± 0.08	0.37 ± 0.1	0.35 ± 0.1	0.34 ± 0.08	<.0001
CDVA (LogMAR)	0.78 ± 0.29	0.30 ± 0.08	0.29 ± 0.1	0.27 ± 0.07	0.26 ± 0.07	.015
Sphere (D)	−0.22 ± 1.1	−0.9 ± 0.44	−0.66 ± 0.66	−0.49 ± 0.71	−0.25 ± 0.86	.9
Cylinder (D)	−2.46 ± 0.92	−0.97 ± 0.3	−0.89 ± 0.36	−0.80 ± 0.44	−0.70 ± 0.50	<.001
SE (D)	−1.45 ± 1.5	−1.41 ± 0.5	−1.1 ± 0.75	−0.89 ± 0.83	−0.84 ± 0.81	.1
Km (D)	44.5 ± 1.5	45.4 ± 2.2	45.2 ± 2.1	44.7 ± 2.3	44.6 ± 2.5	.8
Delta K (D)	2.52 ± 1.3	0.94 ± 0.7	0.81 ± 0.6	0.78 ± 0.6	0.75 ± 0.6	<.001
Osmolarity (mOsm/L)	294.7 ± 17.0	301.7 ± 21.0	299.5 ± 25.0	292.4 ± 30.5	291.4 ± 34.0	.6
TBUT (s)	10.8 ± 2.9	8.4 ± 3.5	9.7 ± 4.6	9.7 ± 4.4	11.3 ± 4.6	.5
Schirmer (mm)	18.7 ± 3.7	15.3 ± 3.9	16.0 ± 4.6	16.5 ± 5.7	17.3 ± 6.6	.1
ECC (cells/mm^2)	2364 ± 135	2352 ± 158	2341 ± 139	2336 ± 143	2344 ± 142	.09

CDVA = corrected distance visual acuity; Delta K = corneal astigmatism; ECC = endothelial cell count; FALK = femtosecond laser–assisted lamellar keratoplasty; Km = mean keratometry; SE = spherical equivalent; TBUT = tear breakup time; UDVA = uncorrected distance visual acuity
*Between preoperatively and 12 months postoperatively

Table 2. Biomechanical corneal characteristics over time.

	Mean ± SD					
		Postoperative				
Parameter	Preoperative	1 Month	3 Months	6 Months	12 Months	*P* Value*
CCT (µm)	540 ± 49	550 ± 40	549 ± 43	552 ± 52	554 ± 50	.07
IOP Goldmann (mm Hg)	15.7 ± 2.4	16.1 ± 2.2	16.4 ± 2.5	16.6 ± 2.8	16.4 ± 3.2	.1
IOPcc (mm Hg)	16.6 ± 2.4	16.6 ± 2.1	16.9 ± 2.7	17.1 ± 3.1	17.2 ± 3.4	.4
IOPg (mm Hg)	15.9 ± 2.4	15.9 ± 2.3	16.3 ± 2.9	16.7 ± 3.2	16.7 ± 3.2	.2
CH (mm Hg)	10.3 ± 2.8	10.0 ± 2.7	10.0 ± 2.6	9.8 ± 2.8	9.8 ± 3.0	.06
CRF (mm Hg)	10.1 ± 3.4	10.5 ± 3.0	10.6 ± 2.7	10.3 ± 2.9	9.8 ± 2.8	.5

CCT = central corneal thickness; CH = corneal hysteresis; CRF = corneal resistance factor; IOPcc = cornea-compensated intraocular pressure; IOPg = Goldmann-correlated intraocular pressure
*Between preoperatively and 12 months postoperatively

There were no significant changes in ECD during the postoperative period (Table 1).

The mean tear osmolarity value was higher 1 month postoperatively than preoperatively ($P = .07$) (Table 1). The osmolarity returned to the preoperative normal value by 1 year postoperatively ($P = .08$).

The mean decrease in the TBUT 1 month after surgery was statistically significant ($P < .001$). There was a statistically significant improvement in the TBUT between 1 month and 12 months postoperatively ($P < .001$). There were no statistically significant differences between the preoperative TBUT and the value at 1 year ($P = .5$) (Table 1).

Although the mean Schirmer values decreased significantly 1 month postoperatively ($P < .001$), they increased significantly thereafter and there was no significant difference between preoperative values and 12-month postoperative values ($P = .1$) (Table 1). Three patients had symptomatic dry eye after surgery that resolved with topical medication in all cases.

From the 1-month to the 12-month postoperative visits, the CDVA changed less than 1 line in 17 eyes (89.5%). Sixteen eyes (84.2%) had a change in the SE manifest refraction of less than 1.00 diopter during that period.

Intraoperative PTK to the recipient stromal bed was performed in 5 eyes after the host lenticule was excised and before the donor lenticule was transplanted due to visible residual haziness of the stromal bed. A mean of 43 µm of corneal tissue was ablated from the RSB. However, 3 of the 5 cases had residual corneal scars that were not visually significant at the postoperative visits. Postoperative PTK to the stromal bed was not performed in any case.

No intraoperative complication was observed. Complete reepithelialization was seen in all eyes when the bandage lens was removed 1 week postoperatively. One patient who had developed interface haze in early postoperative visits was scheduled for flap removal with a follow-up PTK procedure to be performed on the host corneal tissue; however, the patient failed to return and was excluded from the study. Residual corneal scar tissue was seen 8 eyes, even though PTK was performed intraoperatively in 3 of the eyes.

Table 3. Postoperative corneal aberrometry.

	Mean (µm) ± SD				
Parameter	1 Month	3 Months	6 Months	12 Months	*P* Value*
HOAs	2.08 ± 0.35	2.06 ± 0.43	1.99 ± 0.46	1.93 ± 0.56	.07
Primary coma	1.04 ± 0.27	1.02 ± 0.30	1.00 ± 0.33	0.97 ± 0.33	.08
Primary SA	0.36 ± 0.36	0.37 ± 0.37	0.28 ± 0.38	0.33 ± 0.42	.4
Trefoil	1.09 ± 0.34	1.10 ± 0.30	1.05 ± 0.35	1.04 ± 0.38	.1

HOA = higher-order aberrations; RMS = root mean square; SA = spherical aberration
*Between preoperatively and 12 months postoperatively

Regardless of whether removal of the scar tissue was incomplete, the CDVA improved in all 8 eyes postoperatively. Residual scars were not clinically significant to warrant an adjunctive intervention in any of the 8 cases. No other major postoperative complication was observed. The mean residual recipient stromal bed after the femtosecond laser lamellar cut and PTK was 273 μm.

DISCUSSION

Femtosecond laser anterior lamellar keratoplasty with sutures has been reported.[9] However, in 2008 Yoo et al.[4] were the first to present and publish the sutureless femtosecond laser–assisted anterior lamellar keratoplasty technique. The success of this breakthrough is the result of the precise cuts of the donor lenticule and recipient cornea by the femtosecond laser, which enables close apposition of donor tissue and recipient tissue. Previous studies report the efficacy of femtosecond anterior lamellar keratoplasty for the treatment of superficial corneal scars. They found that avoiding sutures minimized suture-related complications, especially suture-induced astigmatism.[4] In a study by Shousha et al.,[5] sutureless femtosecond laser–assisted anterior lamellar keratoplasty improved the CDVA in 13 patients soon after the procedure. The improvement was stable during a long-term follow-up (mean 31 months) with no significant induced astigmatism.

Femtosecond laser–assisted anterior lamellar keratoplasty seems to be appropriate for corneal scars of intermediate depth that do not involve the posterior 250 μm of stroma. Although superficial stromal scars secondary to recurrent corneal erosions and corneal dystrophies can be treated by PTK, this method has major limitations in the treatment of deeper stromal scars. These include a hyperopic shift, significant visual haziness, and clinically significant irregular astigmatism due to ablation of deep corneal scars. For deeper scars, anterior lamellar keratoplasty provides better clarity with a lower risk for rejection, which makes it the preferred technique. In our study, we chose the depth of the femtosecond cuts to allow a residual stromal bed of at least 250 μm in the recipient cornea. This thickness is presumed to be sufficient to prevent keratectasia.[10]

In our study, femtosecond laser–assisted anterior lamellar keratoplasty led to a significant improvement in UDVA and CDVA. At the last examination, the CDVA was better than preoperatively in all patients. The postoperative CDVA was 20/40 or better in 78.9% of eyes. This is comparable to the postoperative CDVA in reports of PKP (73% to 91%),[11] anterior lamellar keratoplasty (72% to 92%),[1,12,13] femtosecond laser–assisted lamellar keratoplasty using sutures (86%),[14] and femtosecond laser–assisted anterior lamellar keratoplasty (79.9%).[4,5]

We did not include corneal dystrophies in our case series; hence, there was no recurrence of this condition. This is in contrast to a previous report of femtosecond laser–assisted anterior lamellar keratoplasty.[5] Refractive surgery for ametropia after femtosecond laser–assisted anterior lamellar keratoplasty was also not performed. Shousha et al.[5] report the recurrence of corneal dystrophy and corneal haze after postkeratoplasty PRK to be the cause of postoperative visual loss.

No significant change in CDVA occurred between 3 months and 12 months postoperatively in our study. This is comparable to results in a previous study of femtosecond laser–assisted anterior lamellar keratoplasty[5] in which after 24 months, 83.3% of eyes achieved a CDVA within 2 lines of the CDVA at the 5-week postoperative visit. This suggests the postoperative refractive results are stable after 3 months. This period is significantly shorter than the period with other corneal transplantation techniques that use sutures.[15,16]

No significant difference between the preoperative SE and postoperative SE was observed. Moreover, the postoperative refractive astigmatism is com parable to that in other studies of femtosecond laser–assisted anterior lamellar keratoplasty[4,5] and lower than the results reported in the literature for PKP and anterior lamellar keratoplasty.[1,12,13,15–17] One probable reason for a statistically insignificant postoperative refractive shift was the precision of the laser corneal cuts, which created a near-perfect fit of the donor tissue and recipient bed. Another likely reason is that no sutures were used to secure the donor cornea.

We also evaluated the changes in corneal HOAs. We did not perform aberrometry at the preoperative visit because of fixation problems and the low reproducibility of preoperative values. No significant changes in the postoperative aberrometric values were observed during the follow-up, confirming the stability of the results of the surgery. The decagonal trephination used in this study reduces rotational slippage of the graft and improves its stability compared with conventional round trephination, which was performed in previous studies of femtosecond laser–assisted anterior lamellar keratoplasty.[4,7] Because the graft thickness was not sufficient, we used vertical cuts instead of other patterns (eg, top hat, zigzag).

Pathologies such as Fuchs dystrophy, high myopia, and glaucoma are reported to reduce CH, which represents corneal viscosity made by collagen structure and hydration state, and the CRF, which represents corneal elasticity. Corneas after LASIK and immediately after cataract surgery are reported to have lower CH and CRF values. Similar to previous findings by Shin et al.[18] in eyes having PKP, our study found that CH decreases significantly after femtosecond laser–assisted anterior lamellar keratoplasty. However, we found no significant change in the CRF.

Although the IOPcc and IOPg were higher postoperatively than preoperatively, the differences were not statistically significant. The IOPcc values were higher than IOPg and Goldmann applanation tonometry (GAT) values at all timepoints, and no significant difference was seen between the 2 latter tonometry techniques. These findings are in accordance with those in previously reported for normal corneas.[19] In contrast, in a study by Touboul et al.[20] of normal corneas, the IOPg and IOPcc values were significantly different from the GAT and IOP measurements, although no difference was found between the IOPcc and the IOPg values. The difference in these results from those in our study may be due to the lower mean CCT in our series; the CCT directly affects the IOPcc.

Once the epithelial gap fills in, the endothelial pumping function secures the lenticule's place, although tensile strength develops slowly by wound healing.[10] Graft stability and survival after keratoplasty are closely related to an intact corneal endothelial function. The reported rate of annual endothelial cell loss in patients who had PKP is between 12% and 17%.[21] Short-term comparative studies[2,15] showed a lower rate of endothelial cell loss after deep anterior lamellar keratoplasty (DALK) (5% to 6% in the first year) than after PKP.

In healthy eyes, the ECD decreases annually by approximately 0.6%.[22] Because of preoperative corneal haze, we were unable to calculate the ECD in some patients. However, the overall 1-year endothelial cell loss in our series (0.8%) is much lower than after PKP and DALK grafting and comparable to that in healthy eyes. This is of particular significance in younger patients, who have longer life expectancy and will likely require future surgeries. It has been reported that ocular surface physiology can be affected by ocular surgeries.[23] The changes in the ocular surface and tear film have been reported to be a cause of graft rejection after keratoplasty.[24]

In our study, 3 indices of tear-film stabilization (tear osmolarity, Schirmer test, TBUT) deteriorated significantly from preoperative values at 1 month postoperatively. However, over the 1-year follow-up, all 3 indices gradually improved, eventually reaching preoperative levels. Another study[25] found similar TBUT results after lamellar keratoplasty. Özdamar et al.[26] concluded that tear-film changes and secondary dry-eye symptoms may be related to mechanical injury of cornea, inflammatory reactions, tissue edema, and postoperative corneal wound healing and inferred that these factors can lead to temporary tear-film mucoprotein dysfunction and poor distribution of tears on the ocular surface. Corneal sensation decreases after corneal nerve fibers are damaged during surgery. Also, reduced corneal sensation caused by epithelial toxicity to the benzalkonium chloride in eyedrops deteriorates ocular surface stability.

Anwar and Teichmann[27] report that the success rate of the big-bubble DALK technique is as high as 80% to 90%. In another study, Noble et al.[17] report a 14% incidence of Descemet membrane perforation when the Melles technique was used. Busin et al.[16] report that 16% of the donor lenticules prepared using a microkeratome were not appropriate for use in lamellar graft.

Penetrating keratoplasty can also have potential sight-threatening intraoperative complications.[28] In addition to a lower rate of complications in donor tissue preparation, femtosecond laser technology creates more precise lamellar cuts. In our study, there were no intraoperative complications or cases of Descemet membrane rupture, which is consistent with previously reported results of femtosecond laser–assisted anterior lamellar keratoplasty.[4,5]

We excluded patients with dense corneal scars because the scars would interfere with preoperative depth calculation by OCT and femtosecond laser–beam application during surgery. However, inadequate removal of the hazy cornea was the most common complication in our study. Although during follow-up visits 9 eyes had some degree of residual corneal scar in the graft–bed interface, only 1 had a scar significant enough that the patient was scheduled for PTK under a donor button. In all 9 patients, residual scar tissue was the result of the preoperative miscalculation of scar depth and not of interface haze. (The residual scars were in the same place as the original scar.) This miscalculation is probably due to the difference between the refractive index of scar tissue and that of normal tissue.[29] Although most of these cases had good visual outcomes, the inability to remove the entire involved hazy corneal host tissue is a shortcoming of femtosecond laser–assisted anterior lamellar keratoplasty because the goal is to leave a 240 μm residual bed. With DALK, the entire hazy or scarred tissue will likely be removed.

Because we left an RSB of at least 250 μm (generally considered the minimum safe depth for LASIK), there were no cases of significant myopic progression suggestive of ectasia. On the other hand, a follow-up of 1 year is too short to observe the potential for the development of corneal ectasia and longer follow-up periods are needed.

In this study, no visually significant interface haze was noted; such haze is considered a major complication of lamellar corneal grafts. This may be because the femtosecond laser creates a smoother interface between the donor lenticule and recipient cornea. No eye in our study developed epithelial ingrowth, which can probably be attributed to the precision of cuts that left no gap between the host lenticule and the donor lenticule.

Recently, Bonfadini et al.[7] reported 6 patients who had femtosecond laser–assisted anterior lamellar keratoplasty procedure with 2 RSB thicknesses (250 μm versus 50 μm). We believe that the RSB thickness should be greater than 250 μm to ensure adequate support.

To our knowledge, our study is the first to report the effect of femtosecond laser–assisted lamellar keratoplasty on the ocular surface status, aberrometry results, and ocular hysteresis. Because these are important factors in graft survival (ocular surface condition) and quality of vision (aberrometry), all should be considered before choosing which type of keratoplasty to perform (ie, lamellar versus penetrating/conventional versus femtosecond laser–assisted).

The main limitation of this study is its noncomparative design. Further studies are required to compare the results of DALK and PKP with those of femtosecond laser–assisted anterior lamellar keratoplasty.

In conclusion, femtosecond laser–assisted anterior lamellar keratoplasty was an efficient and safe procedure for vision improvement in eyes with anterior corneal pathology. The results were fairly stable during the 1-year follow-up.

WHAT WAS KNOWN

- After femtosecond laser–assisted anterior lamellar keratoplasty, visual acuity and refraction improve significantly and the results are fairly stable over the long term.

WHAT THIS PAPER ADDS

- Corneal biometric values decreased after femtosecond laser–assisted anterior lamellar keratoplasty.
- Corneal aberrometry improved during the follow-up.
- Ocular surface parameters deteriorated soon after the surgery but were similar to preoperative values after 1 year.

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