Optical pachymetry–guided custom excimer laser-assisted lamellar keratoplasty for the surgical treatment of keratoconus

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PURPOSE: To evaluate the anatomic and functional results of optical pachymetry–guided custom excimer laser–assisted lamellar keratoplasty in keratoconus patients.

SETTING: Eye Clinic, University of L'Aquila, L'Aquila, Italy.

DESIGN: Prospective noncomparative case series.

METHODS: Patients with keratoconus having unilateral surgery using custom excimer laser–assisted lamellar keratoplasty were evaluated. A transepithelial excimer laser ablation was planned to leave an estimated uniform thickness residual stromal corneal bed of 200 μm. The donor lamella was prepared with the excimer laser and subsequently sutured to the host cornea using 16 single 10-0 nylon sutures. The eyes were examined preoperatively and 3, 6, 12, and 24 months postoperatively. Outcome measures were uncorrected (UDVA) and corrected (CDVA) distance visual acuities, manifest refraction, computerized videokeratography, pachymetry, and endothelial specular microscopy.

RESULTS: Of the forty-three treated eyes, 35 were available at the 24-month follow-up visit, at which time the UDVA was better than 20/60 in 16 patients (45.7%) and the CDVA was 20/40 or better in 31 patients (88.6%). The mean refractive astigmatism was −2.11 diopters (D) ($P<.05$) and the mean spherical equivalent manifest refraction, −2.60 D ($P<.05$). No statistically significant changes in mean corneal endothelial cell density were observed postoperatively. In 1 case, the donor lamella was exchanged secondary to an altered reepithelialization process with initial corneal melting.

CONCLUSION: Two-year findings indicate that pachymetry-guided custom excimer laser–assisted lamellar keratoplasty is a useful surgical treatment for moderate to advanced keratoconus, preventing the need for the more invasive procedure of penetrating keratoplasty.

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In the surgical treatment of keratoconus, the purpose is to improve the refractive properties of the cornea by reshaping its curvature, to restore its structural and tectonic characteristics by increasing the corneal thickness, and when transparency is affected, to reestablish optical properties. Several authors propose different techniques for anterior lamellar keratoplasty.[1,2] The common principle in all lamellar keratoplasty techniques is to selectively remove only the pathological tissue, saving the deeper corneal layers (Descemet membrane and endothelium), and to restore the normal corneal thickness by implanting a lamellar graft. However, hand dissection is a difficult, painstaking procedure that is rarely as precise as required. As a result, microperforation and macroperforation can occur, which may prompt the surgeon to convert to penetrating keratoplasty (PKP).[3,4] More often, some corneal stroma is left attached to Descemet membrane. The uneven quality of the resulting stromal surface can induce scar formation over time, which in turn can significantly affect visual acuity. In addition, the lack of standardization and reproducibility is a major disadvantage of procedures involving hand dissection.[5] To prevent these problems, some surgeons began using an excimer laser to remove the recipient corneal stroma, leaving a good-quality stromal bed surface.[6]

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As a result, excimer laser–assisted lamellar keratoplasty was conceived as an alternative to PKP for the treatment of keratoconus.[7,8] The use of the excimer laser allowed us to standardize lamellar keratoplasty by simplifying the surgical process, which decreased surgical time and intraoperative and postoperative complications.[9,10]

In the past few years, the development of new laser devices and custom ablation algorithms has improved results and expanded treatment indications for excimer laser technology. The present study evaluated the anatomic and functional results of treating keratoconus patients intolerant to spectacles and contact lenses with custom excimer laser–assisted lamellar keratoplasty.

PATIENTS AND METHODS

Eyes of keratoconus patients were included in a prospective noncomparative case series between December 2006 and March 2010. The Ethics Committee, School of Medicine, University of L'Aquila, approved the study, and all patients provided informed consent.

Selection criteria were vision that was poorly corrected with spectacles or contact lenses, contact lens intolerance, superficial corneal opacities only, no deep striae, and pachymetry measurement greater than 350 μm. Patients with diabetes, connective tissue disorders, glaucoma or intraocular hypertension (≥20 mm Hg), dry-eye syndrome, retinal disorders, and amblyopia were excluded from the study, as were pregnant women.

Each patient had complete eye examinations including uncorrected distance visual acuity (UDVA), corrected distance visual acuity (CDVA), manifest refraction, slitlamp biomicroscopy, intraocular pressure, and fundus evaluation. Pupillometric analysis was performed using a dynamic automated pupillometer (pMetrics, iVis Technologies); pupils larger than 7.5 mm under scotopic conditions were excluded from the study. Corneal topography and corneal thickness were analyzed during each examination using a high-resolution tomographer (Precisio, iVis Technologies) and computerized videokeratoscopy (Keratron Scout, Optikon 2000 SpA); 4 keratoscopic images were obtained from each eye, and the best one was chosen. The keratometric difference values at 3.0 mm were considered to be the keratometric astigmatism. Corneal thickness was evaluated using a 50 MHz ultrasound pachymeter (Corneo Gage Plus, Sonogage, Inc.), and corneal endothelial morphology was evaluated using noncontact endothelial specular microscopy (Seed SP 500, Seed Co., Ltd.). The endothelium was analyzed for quantitative (endothelial cell density [ECD = number of cells/mm^2]) and qualitative (coefficient of variation [CoV = standard deviation cell area/mean cell area]) parameters. The measurements were taken preoperatively and 3, 6, 12, and 24 months after surgery.

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Surgical Technique

All procedures were performed by the same surgeon (L.S.) at the same clinic. The iVis Suite integrated platform (iVis Technologies) was used to perform custom excimer laser–assisted lamellar keratoplasty. The platform consists of a surgical planning software application (Corneal Lamellar Ablation for Transplantation), a corneal morphology data source (Precisio), and a high-frequency excimer laser (iRES). The 3-step surgical procedure (Figure 1) creates a thin, uniform-thickness receiving bed and a dimensionally matched donor lamella.

Donor Ablation Donor corneas preserved in chondroitin sulfate and dextran medium (Optisol, Bausch & Lomb) were positioned on a purpose-designed concave support with the endothelial side exposed to the laser. The surgeon then uniformly reduced the donor cornea thickness with the excimer laser. The mean thickness obtained was 343 μm ± 27 (SD) (range 303 to 407 μm). The donor cornea was then inverted on a convex support with the epithelial side exposed for excimer laser ablation. On the perimeter, a saddle of 250 μm depth was performed by positioning on the center a 7.5 mm diameter mask to obtain a wing of the lamella. The donor cornea was then punched using an 8.5 mm suction punch (Hanna Suction System, Moria-Dugast).[11] This punch consists of a concave polytetrafluoroethylene (Teflon) well in which the donor corneal–scleral shell is secured by gentle suction. A cylindrical guide ensures that the disposable razorblade trephine is perpendicular during punching from the endothelial aspect.

Recipient Ablation The receiving bed was created using a 3-dimensional pachymetry map obtained from the tomographer and calculating the intersection of an ideal surface referenced from the posterior surface of the cornea. This would ideally result in a uniform thickness corneal bed for the eye. The irregular volume above this ideal surface was removed with the high-frequency excimer laser (Gaussian flying-spot 650 μm, 1000 Hz, 193 nm) with the patient under topical anesthesia (ropivacaine 1%). A round nonablatable plastic 7.5 mm mask (masking the area outside 7.5 mm) was placed on the cornea to create a vertical edge to the ablation, after which the transepithelial ablation was performed. The maximum net mean ablation depth was 491 ± 91 μm, and the minimum mean ablation depth was 198.1 ± 29.9 μm. The minimum estimated residual stromal thickness of the completed receiving bed was set at 200 μm.

Lamellar Keratoplasty Local anesthesia was achieved with a peribulbar injection of 10 cm^3 of bupivacaine 0.5%–mepivacaine 4.0%. The patient was prepared and draped in the typical manner. Several drops of povidone–iodine 5.0% solution were instilled in the inferior fornix, and a lid speculum was inserted to keep the eye wide open. Using a circular movement with a disk knife (Alcon Laboratories, Inc.), a 2.0 mm stromal pocket was obtained around the

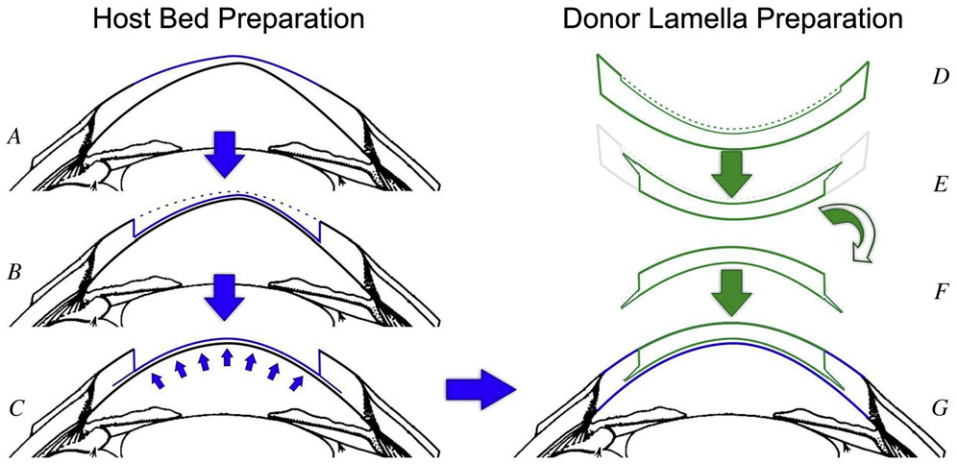

Figure 1. The recipient cornea (*A*) is prepared to remove the irregular keratoconic thickness by custom excimer laser ablation (*B*), resulting in the formation of a uniform thickness receiving bed (*C*). The laser first thins the donor cornea (*D*) and then shapes the donor perimeter to create a saddle and obtain a wing of the lamella (*E*). After it is punched, the completed donor (*F*), as a complement to the planned recipient bed, is sutured in place (*G*), yielding a full-thickness normalized postoperative condition.

360-degree circumference of the ablation floor. The donor lamella was then secured into the recipient bed with 4 cardinal sutures of 10-0 nylon at the 6 o'clock, 12 o'clock, 9 o'clock, and 3 o'clock positions. Next, the wing of the donor lamella was introduced into the stromal pocket and 16 interrupted 10-0 nylon sutures were placed. Finally, the knots were buried and intraoperative suture adjustment was performed.[12] At the end of surgery, the speculum was removed and the eye was patched. The patch was removed the day after the surgery.

The postoperative therapy consisted of topical ofloxacin 3.0% 3 times daily until complete reepithelialization. Topical dexamethasone 0.1% was administered for at least 1 month and then tapered and titrated. Within 3 months postoperatively, all patients discontinued their medication. Preservative-free artificial tears (sodium hyaluronate 0.2%) were used for up to 6 months. Two months after surgery, the sutures responsible for major graft distortion began being removed guided by corneal topography analysis. Over the following 7 months, all remaining sutures were selectively removed to achieve the most regular corneal curvature possible. Suture removal was completed by the 9-month follow-up examination.

Statistical Analysis

Data were collected postoperatively and entered into an Excel spreadsheet (Microsoft Corp.) for subsequent analysis. Data are reported as the mean ± standard deviation. Statistical analysis was performed using the Student *t* test. A *P* value less than 0.05 was considered statistically significant.

RESULTS

The study enrolled 43 eyes of 43 keratoconus patients. The mean age of the 31 men and 12 women was 35.1 ± 9.0 years (range 21 to 61 years). All 43 patients attended the 12-month follow-up; 35 patients attended the 2-year follow-up examination. Table 1 shows the preoperative and postoperative patient data.

There were no complications during surgery. All corneas were clear on the first postoperative day, and reepithelialization was completed within 2 weeks after surgery (Figure 2) except in 1 eye. In that eye, the donor lamella was exchanged after approximately 20 days secondary to an altered reepithelialization process with initial corneal melting.

In all patients, the corneal sutures were removed between 2 months and 9 months (mean 5.2 ± 3.3 months) postoperatively. No immunologic rejections were observed. There were no cases of corneal vascularization or infection. No compression sutures or relaxing incisions were placed.

Visual Acuity

The preoperative UDVA was 20/60 or worse in all cases. The postoperative UDVA was better than 20/60 in 15 (34.8%) of 43 eyes at 3 months, 20 (46.5%) of 43 eyes at 6 months, 20 (46.5%) of 43 eyes at 1 year, and 16 (45.7%) of 35 eyes at 2 years (Figure 3). The mean UDVA at all follow-up examinations was significantly better than preoperatively.

The preoperative CDVA was 20/40 or better in 20 eyes (46.5%). Postoperatively, the CDVA was better than 20/40 in 29 eyes (67.4%) at 3 months, 31 eyes (72.1%) at 6 months, 39 eyes (90.7%) at 1 year, and 31 eyes (88.6%) at 2 years (Figure 4). The mean CDVA at all follow-up examinations was significantly better than preoperatively.

By 2 years, the CDVA had improved by 1 line in 6 (17.1%) of 35 eyes and by 2 or more lines in 24 eyes (68.6%). The CDVA had decreased by 1 line in 2 eyes (5.7%); no eye lost 2 or more lines.

Refraction

The decrease in the mean manifest refractive spherical equivalent from preoperatively to 2 years postoperatively was statistically significant ($P = .024$). The decrease in refractive cylinder was also statistically significant ($P = .0001$).

Table 1. Preoperative and postoperative patient data.

Parameter	Preoperative (n = 43)	Postoperative 3 Mo (n = 43)	6 Mo (n = 43)	12 Mo (n = 43)	24 Mo (n = 35)
UDVA (logMAR)					
Mean ± SD	1.0 ± 0.96	0.80 ± 0.72	0.72 ± 0.80	0.64 ± 0.66	0.57 ± 0.51
P value	—	.278	.145	.046*	.019*
CDVA (logMAR)					
Mean ± SD	0.34 ± 0.21	0.30 ± 0.59	0.24 ± 0.60	0.19 ± 0.15	0.15 ± 0.47
P value	—	.676	.350	.0001*	.020*
MRSE (D)					
Mean ± SD	−4.89 ± 4.44	−3.52 ± 3.06	−3.23 ± 3.11	−3.75 ± 3.55	−2.60 ± 3.95
P value	—	.115	.048*	.192	.023*
Refractive cylinder (D)					
Mean ± SD	4.21 ± 2.26	2.62 ± 3.35	1.37 ± 0.53	1.71 ± 0.65	2.11 ± 0.65
P value	—	.012*	.0001*	.0001*	.0001*
Keratometric astigmatism (D)					
Mean ± SD	5.40 ± 3.14	7.53 ± 6.18	3.17 ± 2.74	3.28 ± 1.62	3.52 ± 0.85
P value	—	.047*	.0001*	.0001*	.0001*
K reading (D)					
Mean ± SD	48.23 ± 5.82	44.69 ± 3.29	46.20 ± 3.43	45.25 ± 3.45	44.83 ± 3.72
P value	—	.0001*	.052	.001*	.001*
ECD (cells/mm^2)					
Mean ± SD	2095 ± 192	2021 ± 196	2025 ± 174	2042 ± 190	2049 ± 157
P value	—	.081	.080	.202	.258
Corneal endothelial CoV (SD cell area/mean cell area)					
Mean ± SD	27 ± 6	30 ± 7	29 ± 7	27 ± 5	27 ± 6
P value	—	.267	.463	.592	.563
Corneal thickness (mm)					
Mean ± SD	411 ± 24	620 ± 50	632 ± 50	650 ± 63	606 ± 28
P value	—	.0001*	.0001*	.0001*	.0001*

CDVA = corrected distance visual acuity (spectacle); CoV = coefficient of variation; ECD = endothelial cell density; K = keratometry; MRSE = manifest refraction spherical equivalent; UDVA = uncorrected distance visual acuity
*Statistically significant versus preoperatively ($P < .05$)

Corneal Topography

The mean average keratometry readings on corneal topography were statistically significantly decreased from preoperatively at all postoperative visits. At 2 years, corneal topographic patterns were classified as regularly astigmatic in 28 (80.0%) of 35 eyes. During the follow-up, the corneal patterns remained stable in all eyes and no substantial changes were noted (Figure 5).

Corneal Structure

The mean thinnest value of the cornea increased significantly from preoperatively to 3 months postoperatively ($P < .011$). The wing of the donor lamella was firmly integrated in the host cornea (Figure 6). No significant changes in corneal thickness occurred from 3 months to the end of the follow-up (Table 1). There was no statistically significant difference in ECD or CoV between the preoperative visit and the postoperative visits (Table 1).

DISCUSSION

In keratoconus patients, long-term model-predicted graft survival and endothelial densities are higher after lamellar keratoplasty than after PKP. Compared with PKP, lamellar keratoplasty provides higher survival of the corneal endothelium and the graft as well as comparable visual acuity.[13] Anterior lamellar keratoplasty has significant advantages over PKP. The procedure is extraocular, and intraoperative complications, especially those threatening vision (ie, endophthalmitis and expulsive hemorrhage), are minimized. In addition, steroid therapy can be discontinued postoperatively much earlier than is typical after PKP, minimizing the risk for posterior capsule opacification and glaucoma. As a result, most

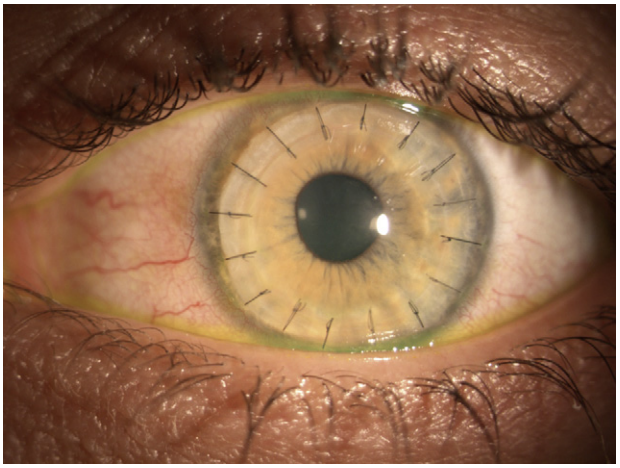

Figure 2. Biomicroscopic examination. Lamellar graft in a 21-year old keratoconus patient 2 weeks after custom excimer laser–assisted lamellar keratoplasty for keratoconus. Sixteen interrupted 10-0 nylon sutures are visible.

keratoplasty surgeons have been unwilling to abandon a well-established technique such as PKP in favor of a time-consuming method with an unknown long-term outcome, such as lamellar keratoplasty. To simplify and standardize lamellar keratoplasty, excimer laser ablation has been used to prepare the recipient bed with encouraging results in small series.[7–9] Studies[14,15] report the utility and accuracy of the excimer laser for reproducible corneal photoablation in lamellar keratoplasty. To improve the anatomic and functional outcome of lamellar keratoplasty in patients with early-stage keratoconus, the technique of excimer laser lamellar keratoplasty with augmented thickness (excimer laser–assisted lamellar keratoplasty) was developed.[8] Excimer laser–assisted lamellar keratoplasty is a procedure in which a deep plano excimer laser ablation is performed on the host cornea and a donor button is sutured into the recipient bed. No thermal or mechanical damage to the cornea in the areas adjacent to the ablation was observed on light microscopy.[15] In addition, the laser did not create adverse alteration of wound-healing responses, including cell migration and proliferation and production of new tissue.[15] Excimer laser–assisted keratoplasty for keratoconus provides an adequate improvement in corneal thickness, which is useful in restoring the optical integrity and structure of the cornea. Functional and anatomic improvements were evident; however, in some cases the mechanical effects of the recipient's original keratoconus persisted, especially in eyes with advanced and decentered ectasia. These disadvantages limited the use of this technique to mild or moderate keratoconus cases.[9,10]

To reduce the mechanical effects and improve these cases, new methods were necessary to regularize the ectasia and to create unique ablations by customizing the lamella and recipient bed. The introduction of a new-generation excimer laser with a comprehensive surgical planning application specific for laser lamellar transplantations allowed the surgeon to create custom ablations for both the receiving bed and the lamella. Specifically, this platform allows surgeons to plan different ablation depths in the same cornea as a function of corneal thickness differentials (pachymetric link) or with corneal aberrations (topoaberrometric link). The concept of custom ablation was developed in the mid-1990s, and it seemed useful to apply the custom ablation strategy to lamellar keratoplasty to improve the surgical technique and the results.[16] A technique for laser-assisted lamellar keratoplasty using pachymetric data (pachymetry-assisted laser keratoplasty) was described by Carriazo.[A] To prepare the host cornea, the thickness map was achieved manually using a Corneo Gage Plus pachymeter or automatically using the Pentacam device (Oculus, Inc.). This information was processed directly by the Pachy-Link software (Schwind Eye-Tech-Solutions GmbH & Co. KG.), which automatically generated the ablation profile map to be used by the excimer laser (Esiris, Schwind Eye-Tech-Solutions GmbH & Co. KG.).[17]

Another way to obtain a custom laser lamellar keratoplasty is optical pachymetry–guided excimer laser

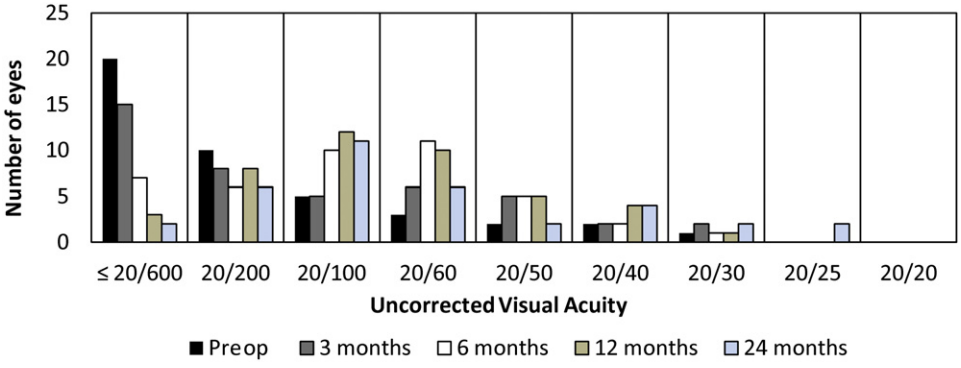

Figure 3. Distribution of the UDVA during the follow-up.

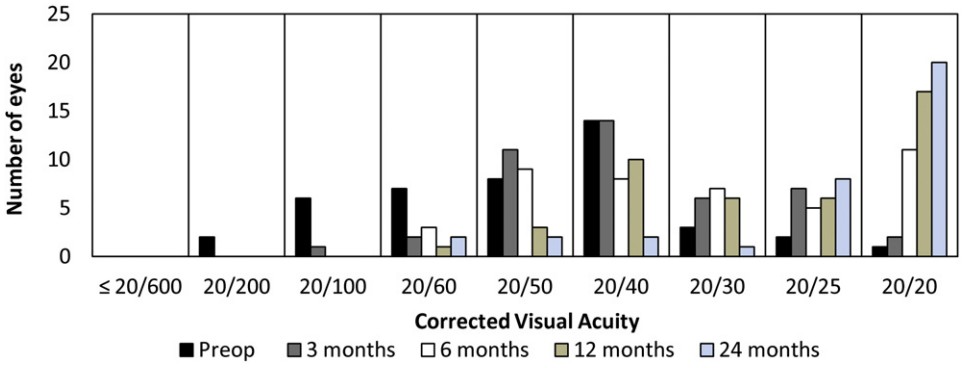

Figure 4. Distribution of the CDVA during the follow-up.

ablation. A surgical software application, Corneal Lamellar Ablation for Transplantation, is used to plan a procedure that is designed to restore the normal corneal pachymetric gradient using devices that provide repeatable anterior elevation, posterior elevation, and pachymetry data. For this technique, a custom refractive surgery platform is used. The platform is a system of integrated devices and software to customize refractive and therapeutic surgery specific to each patient's needs. Unlike microkeratome or standard laser lamellar surgeries, the software removes the irregularities in the cornea in preparation for it to receive a matched, uniform-thickness donor. These traditional methods, by definition, reference the anterior surface and thus leave the corneal irregularities developed from the underlying disease in the postoperative cornea, resulting in significantly more aberrated refraction. When the pachymetry-guided custom recipient ablation is complete, the new membrane characteristics of the residual stromal bed (RSB) (posterior stroma, Descemet membrane, and endothelium) will cause the bed to be positioned along the isostatic line that eliminates the deformations and the aberrations induced from the corneal pathology.[18]

In the present study, the custom technique provided a satisfactory increase in corneal thickness in all patients, restoring structural and optical integrity to the tissue (Figure 7). This increase to normal thickness (>500.0 µm) was accomplished by implanting a donor lamella that had thickness greater than the tissue ablated from the recipient cornea. The improved corneal curvature (<50.0 D) was obtained by the flattening effect of the sutures, which were placed as in other lamellar techniques, such as epikeratophakia in keratoconus patients.[19]

In our series, visual acuity improved after surgery. The final visual results were satisfying and similar to those achieved with PKP[20,21] and other lamellar keratoplasty techniques. Using the big-bubble technique to perform deep anterior lamellar keratoplasty, Fontana et al.[22] found a CDVA of 20/40 or better in 87% of patients 2 years after surgery. In a recent study by

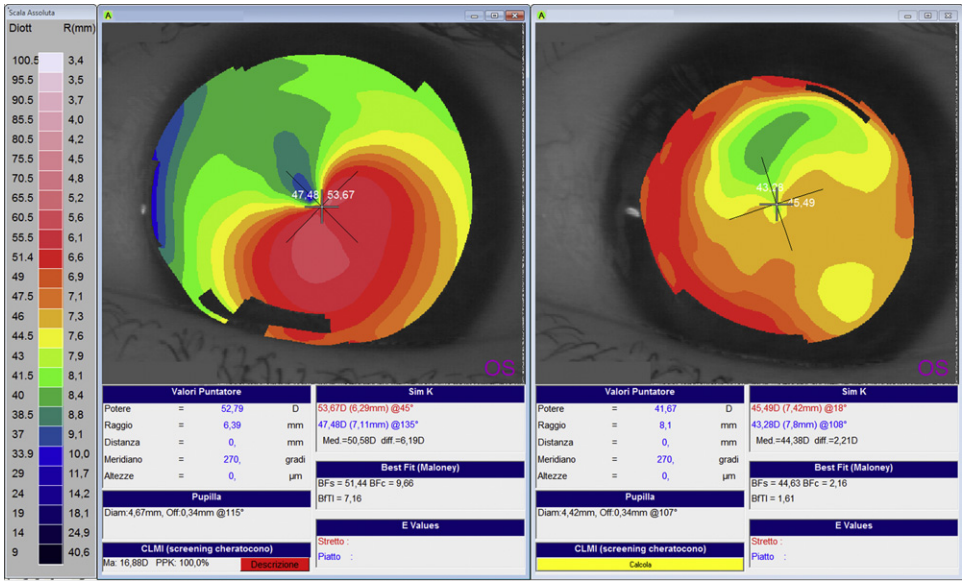

Figure 5. Comparison of the preoperative (*left*) and 2-year postoperative (*right*) topographic corneal maps shows flattening of the cone and regularization of the corneal shape obtained after custom excimer laser–assisted lamellar keratoplasty (absolute scale, axial map) (SIM K = simulated keratometry value).

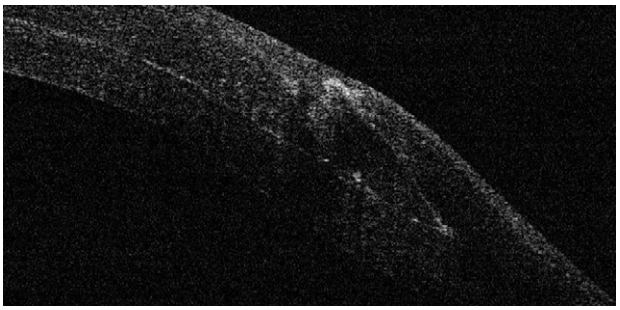

Figure 6. Anterior segment Fourier-domain optical coherence tomography image of the wing of the lamellar graft firmly included in the host cornea 6 months after custom excimer laser–assisted lamellar keratoplasty.

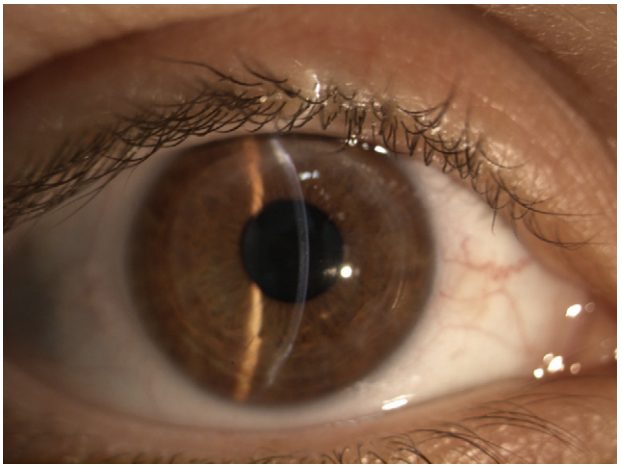

Figure 7. Biomicroscopic examination showed a clear and well-integrated lamellar graft in a 31-year old keratoconus patient who had custom excimer laser–assisted lamellar keratoplasty 2 years previously. No suture is present.

Borderie et al.,[13] deep lamellar procedures with manual dissection that did not completely bare Descemet membrane gave a significantly lower visual recovery than the big-bubble technique and PKP in keratoconic eyes. This represents a potential disadvantage of the lamellar surgical approach. Busin et al.[23] report a CDVA of 20/40 or better in 93.9% of patients 2 years after microkeratome-assisted lamellar keratoplasty. In a study of femtosecond laser–assisted lamellar keratoplasty, Mosca et al.[24] report a mean CDVA of 20/30 at 20 months. Buratto et al.[8] report a mean CDVA of 20/30 in 20 keratoconus patients after excimer laser–assisted lamellar keratoplasty. Bilgihan et al.[9] obtained similar results after treating 5 keratoconus patients with excimer laser–assisted lamellar keratoplasty.

In our previous study[10] of standard excimer laser–assisted lamellar keratoplasty, we obtained a mean CDVA of 20/40 or better in 87.9% of 33 patients after a 2-year follow-up. In the present study, the custom technique gave results comparable to those of the standard technique, with a satisfactory increase in lines of CDVA over preoperative values (85.7% versus 75.7%). However, there were significantly fewer cases (5.7% versus 21.2%) with decreased CDVA (1 or more lines). The better results may have been due to the use of a newer generation laser and a custom technique, resulting in a better, more uniformly thin receiving bed and a better, dimensionally matched donor lamella. This reduced the formation of microstriae, which decrease the quality of vision.

After surgery, the improvement in visual acuity was rather slow but progressive, with very satisfactory results. It is possible that alterations in the interface may affect, in an unpredictable manner and in some cases permanently, the integrity and optical quality of the graft, which would influence the patient's visual recovery.[25] In our study, the interface in all cases was excellent with no clinically significant haze affecting vision. As in laser in situ keratomileusis procedures, the reparative response in the flap interface is absent. This aspect of the postoperative response may be due to the high degree of regularity of the laser dissection and the presence of a uniform support surface capable of more easily stabilizing the juxtaposition between bed and flap with a suture.[23] The slowness of the visual recovery could be due to haze of the graft–bed interface, a reduced ability of the host keratocytes to colonize the rehydrated lamella, or small folds in the recipient bed caused by mechanical tension of the suture on the lamella. However, in the present study, a loss of 1 CDVA line occurred in approximately 6% of cases. We believe all these factors improved spontaneously and steadily over time in most of our patients and could have been the result of individual variability in the processes of integration of the donor lamella.

The early removal of sutures in our study, within 9 months after surgery in all cases, could have affected the patients' refraction because of changes in the spherical equivalent and the refractive cylinder during the postoperative follow-up. Astigmatism improved from a mean of 4.2 D preoperatively to 2.1 D postoperatively. Using the lamellar keratoplasty procedure, it is possible to modulate postoperative astigmatism early and to selectively remove the sutures to stabilize the patient's refraction.

In our series, there was 1 complication; that is, the donor lamella was replaced approximately 20 days

after surgery. This was secondary to an altered reepithelialization process with initial corneal melting. After the exchange, there was normal corneal restoration and complete visual recovery. No graft rejection was reported in the present study, but it was reported in the recent study of femtosecond laser–assisted deep anterior lamellar keratoplasty.[26]

In our procedures, the planned RSB was 200 μm in all cases. No endothelial damage occurred during the 2-year follow-up. In contrast, using an RSB less than 100 μm as the aim, Alessio et al.[27] reported severe endothelial damage, perhaps due to the mechanical trauma caused by shockwaves or the actinic damage from ultraviolet exposure and thermal damage.

All anterior lamellar keratoplasties present additional advantages over PKP with respect to common eye-banking procedures because a quality donor endothelium is not required, thereby enhancing the availability of qualified tissue. Donor corneas discarded for endothelium problems and not suitable for PKP can be used for lamellar procedures.

In conclusion, our 2-year experience indicates that optical pachymetry–guided custom excimer laser-assisted lamellar keratoplasty can be considered a useful surgical technique for the treatment of selected cases of keratoconus. The technique prevents the need for the significantly more invasive procedure of PKP. However, the safety of this surgical technique in the long-term has to be assessed in future studies with a greater number of patients.

WHAT WAS KNOWN

- Anterior lamellar keratoplasty can provide significant advantages over PKP by minimizing the risk for intraoperative complications.

WHAT THIS PAPER ADDS

- The introduction of a new-generation excimer laser with a comprehensive surgical planning application specific for laser lamellar transplantations allows the surgeon to create complementary customized ablations for the receiving bed and the donor lamella.
- Optical pachymetry–guided customized excimer laser lamellar keratoplasty provided an increase in corneal thickness in keratoconic patients and may be a useful surgical alternative for the treatment of selected cases of keratoconus.

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