Sclerocorneal Intrastromal Lamellar Keratoplasty for Pellucid Marginal Degeneration

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Purpose: Surgical management of advanced pellucid marginal degeneration is challenging. To correct both corneal thinning and induced corneal astigmatism, we propose a modified intrastromal lamellar sclero-keratoplasty.

Methods: Corneal thinning was mapped using perioperative optical coherence tomography (OCT). Then through a scleral tunnel, an intrastromal pocket was created by stromal lamellar dissection under OCT guidance. A 300 μm-thick stromal lamellar graft was inserted in that pocket before closing the sclera to increase vertical median keratometry.

Results: Intrastromal lamellar sclero-keratoplasty enabled corneal thinning correction and increased corneal astigmatism correction (−11.6 diopters) without complications.

Conclusions: Intrastromal lamellar keratoplasty with scleral tunnel is efficient in PMD. Corneal thinning is corrected with the intrastromal lamellar keratoplasty, and scleral tunnel closure allows increased corneal astigmatism correction. Perioperative OCT guidance allows better detection of the diseased cornea and is helpful for the lamellar dissection.

Key Words: pellucid marginal degeneration, PMD, intrastromal lamellar keratoplasty, keratoplasty, astigmatism

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Pellucid marginal degeneration (PMD) is a noninflammatory corneal ectasia with crescentic corneal thinning located approximately 1 mm from the limbus.[1] The induced flattening of the vertical meridian causes irregular astigmatism with visual loss.[2] Spectacles or contact lens are initial noninvasive options for visual rehabilitation. Toric intraocular lens (IOL) is a cornea-independent strategy to correct PMD-related astigmatism; other surgeries involve the cornea.[2] Aside from intracorneal ring segments that correct the shape of the cornea,[3] corneal surgeries try to correct the corneal thinning and flattening of the vertical meridian with or without corneal graft. To preserve a patient's endothelial layer, lamellar crescentic surgeries with[4,5] or without keratoplasty[6–8] were developed. Intrastromal lamellar[9] and crescentic lamellar[4,5] keratoplasty by addition of a donor lamellar cornea correct corneal thinning and indirectly astigmatism. The innovative intrastromal lamellar keratoplasty published by Jabbarvand et al[9] limits both astigmatism and irregularity, but significant residual astigmatism often remains. Crescentic lamellar wedge resection removes the thinned part of the cornea, but extent of the resection defines the correction of the astigmatism and can lead to overcorrection.[6–8]

Adapted from the Jabbarvand et al technique, we suggest an intrastromal lamellar sclero-keratoplasty correcting peripheral thinning and preserving the patient's endothelial layer through a scleral tunnel, allowing an increase in the vertical meridian keratometry by tightening the stitches.

We also benefit from material improvement with perioperative optical coherence tomography (OCT). Until now, detecting the thinned corneal area was based on preoperative topographic maps. Perioperative OCT helps to define more accurately the borders of the corneal ectasia and can be helpful to monitor lamellar cut depth.

MATERIALS AND METHODS

Surgical steps are displayed in Figure 1. Surgery was performed under general anesthesia and with perioperative OCT guidance (Rescan system; Zeiss). Limits of the diseased tissue with corneal thinning were detected by perioperative OCT and marked with dermographic pen (Fig. 1A). A conjunctival flap was performed followed by a 2-mm, half-depth scleral incision parallel to the limbus over 10 mm (Fig. 1B). Then scleral tunnel and corneal lamellar dissection were performed centripetally toward the corneal center with a crescent knife through the previously delimited superior edge of corneal ectasia (Figs. 1C, D). A 300-μm-thick corneal lamella was prepared using the Moria ALTK microkeratome. The donor cornea was mounted on an artificial anterior chamber and, after epithelial removal, a 300-μm-thick stromal lamella was removed. We then placed the lamella above the host cornea. The marked edges of the ectasia were clearly visible by transparency through the graft (Fig. 1E). The cutting edges were marked on the donor corneal stroma in a crescent shape following the

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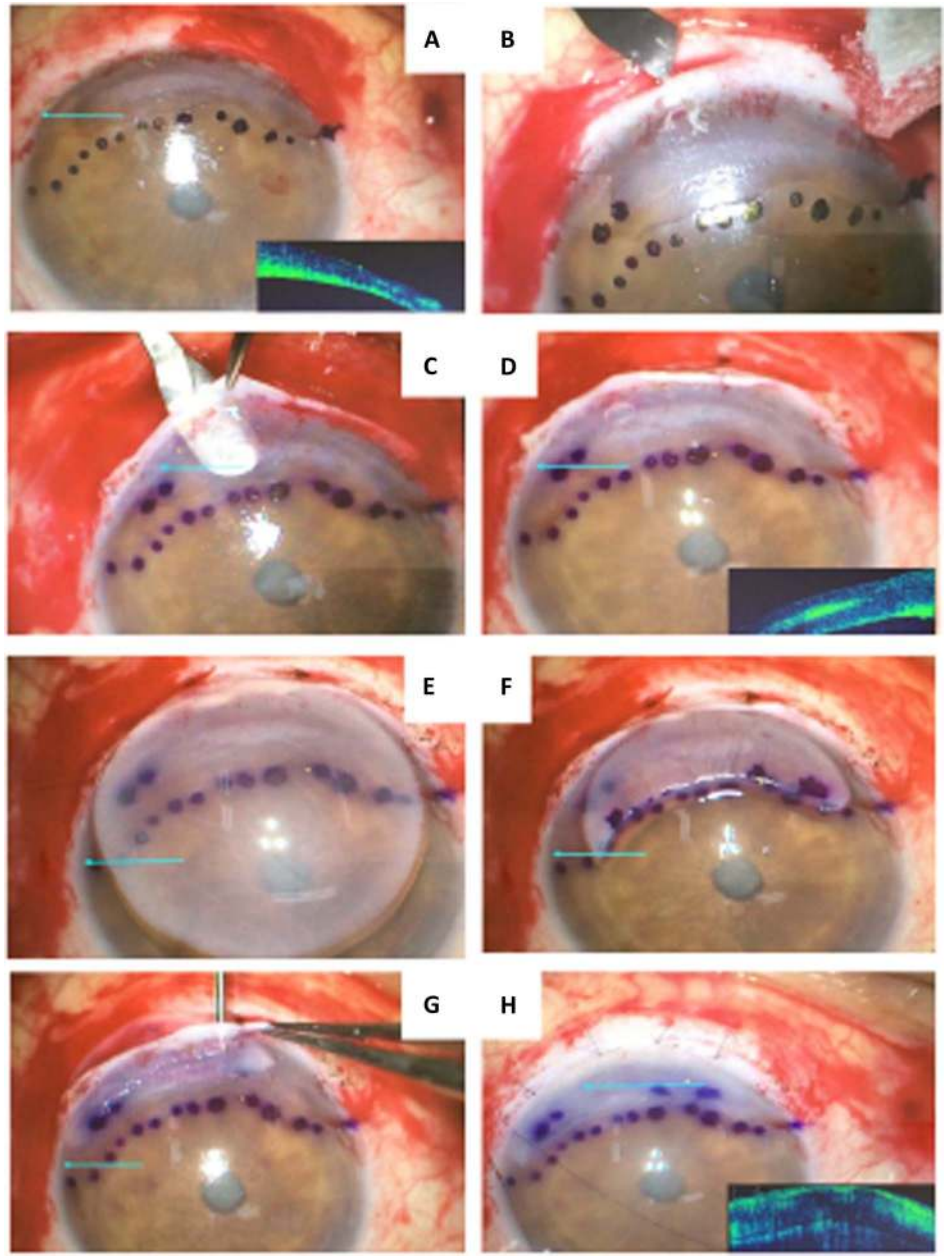

FIGURE 1. Perioperative OCT-guided surgical procedure. A, D, and H, Perioperative OCT imaging in the insert on the bottom right corner. A, Spotting and marking edges of the thinned cornea. B, Conjunctival flap and a 2-mm half-depth scleral incision parallel to limbus with a crescent knife. C, Scleral tunnel and corneal lamellar dissection. D, Stromal dissection assessed with perioperative OCT. E and F, Crescentic graft preparation. G, Placement of the stromal lamellar graft in its pocket. H, Sclera and conjunctiva suture.

marks performed on the corneal pocket and then cut with Vannas scissors (Fig. 1F). The donor crescent-shaped corneal stroma was then inserted in the space created by stromal lamellar dissection (Fig. 1G). The sclera was subsequently sutured with 10/0 Nylon, and conjunctiva was closed with 2 sutures of 10/0 Vicryl (Fig. 1H).

RESULTS

We describe a new technique of intrastromal corneal graft for the surgical management of a patient with PMD (Figs. 2, 3). Diagnosis of PMD was established on slit-lamp examination and corneal topography. The patient also had a dense cataract and reported poor visual acuity with his contact lenses even before the occurrence of cataract. The visual acuity before surgery was limited to hand motion. We agreed with the patient to first perform corneal surgery to improve corneal regularity and to subsequently perform a cataract surgery with an appropriate toric IOL. Operative and postoperative surgical risks are identical to anterior lamellar graft (rejection, keratitis, and perforation). We explained the necessity to postpone the cataract surgery waiting for stabilization of the astigmatism, but we also explained the possible astigmatism drift. The surgery was performed after the patient gave written informed consent. No perioperative or postoperative complications occurred. Postoperative treatment consisted of topical dexamethasone and tobramycin. The visual acuity after a 6-month follow-up

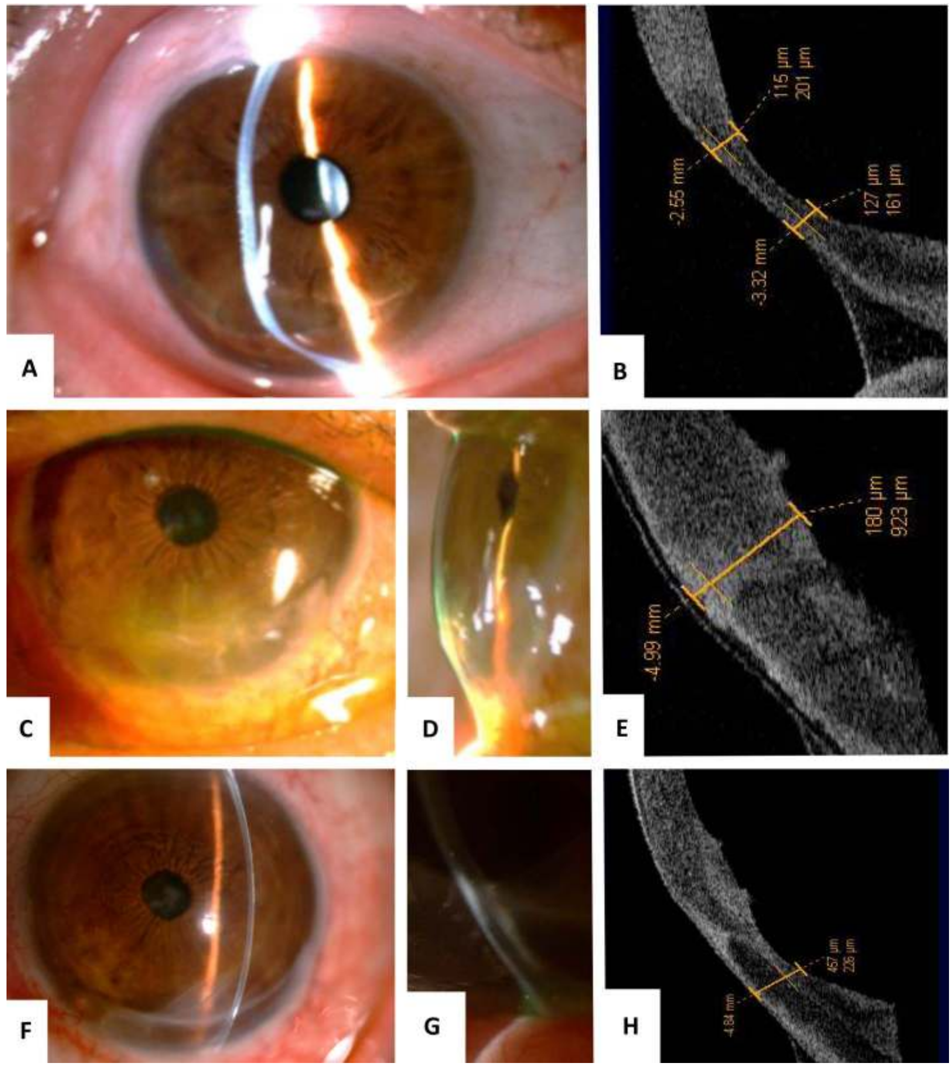

FIGURE 2. Preoperative and postoperative slit-lamp examination and OCT. A, Preoperative slit-lamp examination with a slim beam. The cornea is irregular with flattened central area, thinned area located inferiorly, and a "beer-belly" aspect. B, Preoperative OCT imaging, vertical scan displaying the corneal thinnest inferior part. C and D, Slit-lamp examination of the cornea 3 months after surgery. E, Three-month postoperative OCT imaging, vertical scan in the area of the stromal lamellar graft that displays increased corneal thickness in comparison with the preoperative one. C–G, Slit-lamp examination of the cornea 6 months after surgery. H, Six-month postoperative OCT imaging, vertical scan in the area of the stromal lamellar graft that displays increased corneal thickness in comparison with the preoperative one.

was limited to count-fingers. Corneal topography was performed preoperatively and postoperatively after 6 months. Corneal shape was more regular and corneal astigmatism diminished (−11.6 diopters) (Fig. 3). Preoperative and postoperative flat keratometry varied from 29.8 to 37.6, and steep keratometry varied from 51.6 to 47.8, respectively. Corneal thickness after the surgery ranged from 403 to 726 µM (Fig. 2).

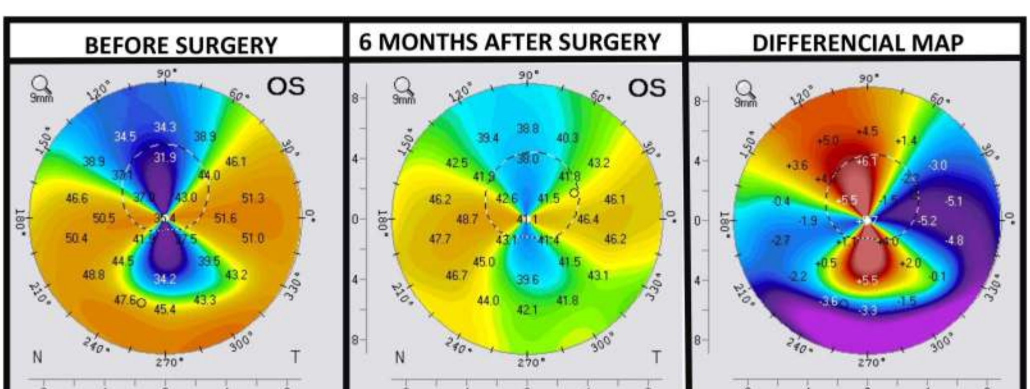

FIGURE 3. Preoperative, 6-month postoperative, and differential anterior sagittal image (Pentacam—Oculus). The stromal lamellar graft reduced corneal astigmatism to 11.6 diopters.

DISCUSSION

This surgery has combined advantages of intrastromal keratoplasty described by Jabbarvand et al[9] associated with a scleral tunnel to correct astigmatism. Intrastromal lamellar keratoplasty preserves the patient's endothelial layer and limits graft rejection.[9] It also allows shorter postoperative corticosteroid treatment. Unlike crescentic lamellar wedge resection that requires an extended lamellar dissection, in our technique, lamellar dissection spares the corneal center avoiding large lamellar dissection through the center of the cornea with the risk of corneal opacity or induced corneal aberration. No corneal sutures are required, avoiding possible related complications such as infectious keratitis, high astigmatism, or patient discomfort. The donor lamellar stroma is introduced in an intrastromal pocket, avoiding possible dehiscence between the graft and the thinned cornea. Infectious risk could be limited because the graft is not in contact with the outside but lie in an intrastromal pocket with a scleral tunnel under a conjunctival flap. Moreover, suturing of the scleral tunnel helps to correct astigmatism. Nevertheless, risks of a lamellar keratoplasty such as graft rejection persist.

In such advanced cases associating severe corneal thinning and astigmatism, surgical management of the corneal disease is required as opposed to less advanced cases where only toric lenses could be proposed after cataract surgery. This patient had 2 issues to deal with: PMD with irregular astigmatism not corrected with a contact lens and dense cataract. Cataract surgery with a toric IOL would not have been a good choice because visual acuity was limited with her contact lens before the occurrence of cataract. Corneal surgery was mandatory to improve visual acuity. We considered a 2-step strategy with first a corneal surgery to attempt to reduce irregular astigmatism and with the subsequent possibility to use a toric IOL after the stabilization of astigmatism. Nevertheless, the patient should be aware of possible astigmatism drift and possible undercorrection with toric IOL.

Despite several advantages of this technique, we still need a lamellar dissection with risk of perforation into the anterior chamber. Nevertheless, the extent of lamellar dissection is limited and we also used the perioperative OCT to monitor the depth of the dissection. Alternatively, preoperative OCT could be used to delineate the thinned area. A possible improvement of this technique and to ease its adoption is to use a femto-assisted lamellar cut of the recipient cornea and also to prepare the crescentic cut of the donor cornea. Perioperative OCT allows an accurate spotting of the edges of ectasia. It could limit the extent of lamellar dissection and reduce the size of the graft.

To summarize, we used OCT-assisted intrastromal lamellar keratoplasty with scleral tunnel to treat a patient with pellucid marginal degeneration. It integrated the advantage of intrastromal lamellar keratoplasty to correct corneal thinning with an extended possibility to correct astigmatism. Perioperative OCT helps to define accurately the edges of corneal ectasia and to perform stromal lamellar cut. Long-term results and more cases are required to validate the benefits of surgery.

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