We used a surgical technique that combines deep lamellar keratoplasty, phacoemulsification, and intraocular lens implantation for treating patients with cataract and corneal stromal disease. Deep lamellar dissection of the cornea was first performed with viscoelastic substances (hyaluronate sodium) until the highly transparent Descemet membrane solely remained. We then created a short corneal tunnel to perform phacoemulsification with low vacuum and intraocular lens implantation. The resilience of the Descemet membrane ensured excellent viewing of the whole anterior chamber as well as the surgical conditions of a closed system. At the end of surgery, a full-thickness donor button was sutured into the recipient bed after its Descemet membrane was stripped. This technique was effective in these 4 patients with cataract and dense corneal opacity.

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Patients who are treated for cataract associated with corneal disease classically undergo a 3-phase surgical procedure (penetrating keratoplasty, extracapsular cataract extraction, and then intraocular lens implantation). However, implementing that technique poses a number of technical problems or difficulties, including in particular a nonnegligible number of complications during capsulorrhexis. The lack of pressure in the anterior chamber, inherent in this open surgery procedure, cannot balance the vitreous pressure; hence, there is a much higher risk of radial capsular cracks. To eliminate that risk, most authors recommend performing capsulorrhexis, or even phacoemulsification, before trephination whenever corneal transparency permits,1-4 or using a temporary keratoprosthesis5 or corneal graft6 when corneal opacity is too great.

Corneal surgery has also acquired, in recent years, a new surgical technique to treat corneal opacities: deep lamellar keratoplasty.7-9 In that process, the corneal stroma needs to be fully and entirely excised to leave only the bare Descemet membrane; then the stroma is replaced by a full-thickness graft.

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METHODS

The operation was performed with the patient under peribulbar anesthesia (Figure 1 and Figure 2). After air was injected into the anterior chamber, a 30-gauge needle connected to a syringe full of viscoelastic substance was inserted into the corneal stroma at the midperiphery level. When the needle reached the deep corneal layers, the viscoelastic substance was injected to separate the posterior stroma from the Descemet membrane. When viscodissection was complete, the cornea was trephinated over a 7.5-mm di-
ameter and 1.2-mm depth. The corneal stroma thus isolated from the Descemet membrane could then be easily excised with scissors. When deep stromal layers persisted, they also were separated from the Descemet membrane by viscodissection and excised. Ultimately, only the fully transparent Descemet membrane must remain, ensuring perfect visualization of the whole anterior chamber while maintaining its tightness. As a matter of safety, we coated the Descemet membrane with viscoelastic substance.

A 3.2-mm corneal incision was then performed, care being taken to penetrate the anterior chamber within trephination limits, then a viscoelastic substance was injected into the anterior chamber. Capsulorrhexis was performed with forceps, and hydrodissection and phacoemulsification were carried out according to the usual technique.

Figure 1. Schematic development of combined surgery. A, Deep lamellar keratoplasty is performed with viscodissection. Finally, only the Descemet membrane remains. Arrow indicates the direction of the ablation of the corneal button. B, Capsulorrhexis, hydrodissection, and phacoemulsification are performed through a corneal tunnel. C, After implantation of an intraocular lens, a corneal graft is stitched on top of the remaining Descemet membrane. Arrow indicates the direction of the placement of the corneal graft.

The capsular bag was then re-inflated with the viscoelastic substance and implantation was performed in the capsular bag. The corneal incision was not sutured.

Finally, the Descemet membrane was rinsed and cleared of any viscoelastic substance, so as to ensure correct positioning of the corneal graft. That graft was prepared from a whole cornea trephinated to 7.5 mm in diameter in which the endothelium was slowly destroyed with a triangular sponge. The graft was then sutured with 10-0 nylon.

Figure 2. Development of combined surgery. A, After air insufflation into the anterior chamber, viscoelastic substance is injected into the stroma to separate the posterior stroma from the Descemet membrane (patient 1). B, After trephination and excision of the stroma, only the highly transparent Descemet membrane remains (patient 1). C, Corneal incision (patient 1). D, Capsulorrhexis (patient 2). E, Phacoemulsification is performed behind the Descemet membrane with very good visibility (patient 1). F and G, Implantation of intraocular lens through the limbal incision (patient 2 with forceps [F], patient 3 with injector [G]). H, A corneal graft is stitched with 10-0 nylon (appearance 2 months postoperatively in patient 2).

RESULTS

Four patients were operated on with this technique, and 3 to 12 months of follow-up was available. Patients’ preoperative and postoperative data are shown in the Table.

There were no complications in 3 patients. In all cases the “divide and conquer” technique was deemed
preferable and safer, and used rather low aspiration rates to prevent any risk of the anterior chamber collapsing. In 1 case, the corneal incision reached the trephination limit, inducing a permanent leak on that site. Fortunately, the Descemet aperture was slightly posterior in relation to trephination; the latter was not enlarged and the operation could be carried out to completion.

Postoperatively, the cornea became clear in all cases. Despite a history of herpetic keratitis and neovascularization, none of the 4 patients manifested any signs of rejection during the postoperative period.

**COMMENT**

Deep lamellar keratoplasty is a delicate surgical technique, but in recent years interest in it has increased, when corneal disease does not affect the endothelial layer.\(^7\)\(^,\)\(^9\) The aim of the operation is to separate the Descemet membrane from the stroma before corneal trephination. The graft can be performed only when all stroma remainders have been excised from the front of the Descemet membrane. The graft is trephinated from a donor’s whole cornea. The endothelial side of the donor’s cornea is wiped with a cotton swab for easy ablation of the Descemet membrane, leaving a perfectly smooth surface on the stromal side. The result is that no scar is formed between the host’s and the donor’s cornneas. The visual results, therefore, were as good as those from transfixing keratoplasty.\(^10\) The advantages of deep lamellar keratoplasty as a treatment for corneal stroma disease are clear. Unlike penetrating keratoplasty, it is exempt from rejection risks, and it preserves high long-term endothelial density and increased globular resilience to trauma.\(^7\)\(^,\)\(^9\)

However, a number of patients eligible for deep lamellar keratoplasty have cataract disease that needs to be treated surgically to restore acceptable eyesight. When 2 surgical procedures are contemplated within the same operative session, surgeons classically perform a triple procedure associating penetrating keratoplasty, extracapsular cataract extraction, and intraocular lens implantation, probably because they fear excessive fragility of the bare Descemet membrane. Patients then lose all the benefits of deep lamellar keratoplasty.

Operative conditions, however, are not optimal when lens surgery is performed openly, because the posterior pressure is not being balanced by the tightness of the anterior chamber. The most frequent complications include incomplete capsulorhexis, incomplete aspiration-irrigation of the cortex, uncertain placement of the intraocular lens, posterior capsule rupture, chorioidal effusion, and even expulsive hemorrhage.\(^1\) Most authors therefore recommend performing capsulorhexis or even phacoemulsification before trephination whenever corneal transparency permits\(^1\)\(^,\)\(^4\) or using a temporary keratoprosthesis\(^5\) or corneal graft\(^6\) if corneal opacity is too pronounced.

Descemet membrane is a condensation of collagen IV and laminin that is 7 to 10 µm thick. Descemet membrane is tough and resistant to enzymatic degradation. In certain corneal ulcerations, such as Mooren ulcer or bacterial keratitis, Descemet membrane remains intact and protrudes as a descemetocoele that is caused by intraocular pressure after dissolution of the overlying stroma.\(^11\)

This is the first demonstration, to our knowledge, that the resilience of the Descemet membrane enables it to withstand the operative duration of phacoemulsification under visibility conditions identical to those of a perfectly clear cornea. This proves that patients eligible for deep lamellar keratoplasty can also be operated on for cataract at the same time and thus keep their endothelium. Such a surgical procedure permits operating on cataract in a “closed system” and reducing the previously mentioned perioperative risks.

However, a number of precautions need to be observed. First, the phacoemulsification probe’s corneal tunnel must not be too long, so as to prevent leaks at the Descemet membrane level, which would jeopardize constant pressure in the anterior chamber. It is also recommended not to perform corneal trephination exceeding 8 mm in diameter, with 7.5 mm being fully adequate. Too-high aspiration rates are also to be avoided, to prevent anterior chamber collapse, in particular at the end of each lens fragment aspiration.

This study demonstrates that observing those recommendations will make it possible to operate on patients with corneal opacity associated with cataract under very acceptable conditions. The patients will experience faster eyesight recovery than with 2-step surgery and yet retain all the benefit of lamellar keratoplasty.

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