Keratoplasty: Moving to the Front

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Penetrating keratoplasty (PKP) has a long track record of high success rates compared to other tissue and organ transplantations. Despite the immunologic privilege of the cornea, the issue of immunological rejection cannot be overlooked and endothelial rejection is observed in up to 20% of eyes undergoing PKP.[1] Repeat keratoplasties after rejection are increasingly more prone to rejection and the potential for a clear cornea becomes progressively lower with subsequent PKPs. Prospective long-term graft survival studies have also revealed disappointing results with PKP, and it is now recognized that graft survival rates and endothelial cell counts continue to decrease for many years after PKP.[2]

Recent advances in surgical technique have prompted a resurgence of lamellar corneal transplant techniques that aim to selectively replace only diseased layers of the cornea. Lamellar keratoplasty (LK) involves replacing either the anterior stroma (anterior lamellar keratoplasty, ALK) or posterior deep stroma and endothelial layer (posterior lamellar keratoplasty, PLK or endothelial keratoplasty, EK). In this issue of *JOVR*, Javadi et al[3] report the results of ALK using the big bubble technique in patients with keratoconus with excellent results that are comparable to, if not better than, traditional PKP.

The advantages of ALK over conventional PKP are well recognized.[4,5] Since ALK is largely a nonpenetrating extraocular technique, it reduces the incidence of intraocular complications such as glaucoma, cataract formation, retinal detachment, cystoid macular edema, endophthalmitis and expulsive hemorrhage. Leaving an intact and healthy recipient endothelial bed obviates problems related to endothelial rejection. The integrity of Descemet's membrane is not violated with LK, therefore a tectonically stronger corneal wound is achieved. Fewer sutures and thus less suture-related astigmatism has likewise been reported in lamellar grafts as compared with PKP.

Despite the distinct advantages of ALK, PKP has remained the most common corneal grafting procedure. Currently, about 50,000 corneal transplants are performed each year in the United States alone,[6] and according to the latest statistics from the Eye bank Association of America, 2% of all cornea transplants were ALK, 70% PKP, and 28% EK.[6] One of the main criticisms of ALK has been suboptimal visual acuity compared with PKP caused by interface problems, irregularity of the lamellar dissection, and residual scarring. These problems have largely been eliminated by new deep ALK techniques which allow removal of the entire corneal stroma down to a bare Descemet's membrane, leading to improved visual outcomes.[4,5] Deep anterior lamellar keratoplasty (DALK) involves the use of deep stromal injection of air[7] or viscoelastic material to separate the stroma from Descemet's membrane.[8,9] Others describe careful manual peeling techniques,[10] and the use of Trypan blue to aid in visualization of Descemet's membrane.[11] Interestingly, the separation of stroma from Descemet's membrane has recently been brought into question, because histologic evidence suggest that the cleavage plane occurs not between the stroma and the Descemet's membrane but actually between banded and nonbanded layers of the Descemet's membrane.[12]

Indications for DALK include most corneal disorders with an intact endothelium, making it the first surgical option in a large group of patients undergoing keratoplasty including the following.

Keratoconus: The most common indication for DALK is probably keratoconus, these patients are the ones to benefit most from preserving their own endothelium. A recent study[13] com-

paring results of DALK with PKP in keratoconus patients matched for preoperative severity showed comparable results.

Hereditary dystrophies: Most hereditary dystrophies including Avellino dystrophy, granular dystrophy and lattice dystrophy are good indications for DALK. Postoperative visual recovery was similar in a randomized clinical trial comparing DALK and PKP,[14] indicating that DALK can be a first choice for hereditary dystrophies.

Ocular surface disease: Severe ocular surface disease with limbal stem cell deficiency is a common presentation of advanced aniridia, Stevens–Johnson syndrome, ocular cicatricial pemphigoid, and chemical/thermal burns. These cases often present with stromal corneal opacities limiting vision following ocular surface reconstruction techniques such as limbal transplantation. These patients are at high risk for full thickness grating and PKP alone is contraindicated. A high rejection rate was reported in limbal transplant patients with simultaneous or secondary PKP, strongly suggesting that DALK is preferable for stromal opacities in these patients.[15] Several reports[16,17] have already shown the efficacy of DALK, combined with limbal transplantation, to reconstruct the ocular surface in severe ocular surface disease.

Therapeutic deep anterior lamellar keratoplasty: LK may be used as a tectonic measure to patch a perforated cornea. Lamellar keratoplasty is preferred over PKP because the latter will often lead to immunological rejection or endothelial decompensation depending on the original disease. LK, on the other hand entails disadvantages such as intralamellar neovascularization, or incomplete removal of pathogens in the case of infectious ulcers. Therapeutic DALK has been reported in cases with phlyctenules[18] and gonococcal keratitis[18,19] with long-term success.

Complications of DALK are mostly related to surgical technique and depend in part on the underlying corneal pathology. Perforation or tears in Descemet's membrane occur in approximately 10–30% of cases, depending on the corneal disease and patient age.[7] Keratoconus patients are more prone to Descemet's membrane rupture than others.[20] In most cases, DALK can still be completed despite a small corneal perforation. Injection of air into the anterior chamber can help tamponade the small perforation and allow the case to be completed.

Contraindications to ALK are corneal decompensation secondary to endothelial dysfunction, deep scars involving Descemet's membrane and eyes with preexisting Descemet's membrane defects. Moderate reduction of vision with mild focal scarring of the Descemet's membrane may be an acceptable compromise to full replacement of healthy endothelium, and is now routinely performed as tectonic deep lamellar keratoplasty for small corneal perforations. Bullous keratopathy is the major contraindication of DALK which requires either penetrating keratoplasty, or one of the posterior lamellar procedures. Keratoconus patients with scars due to acute hydrops may not be good candidates for DALK since air might escape through the break in Descemet's membrane and prevent complete dissection.

Finally, it should be noted that although endothelial rejection does not take place after DALK, stromal rejection may still occur and requires treatment.[21] Other complications which are unique to ALK include interface neovascularization and infections.[22] Nonetheless, the current safety and outcomes data clearly support the routine use of DALK in any patient with intact endothelial function.

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