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Evolution of Lamellar Keratoplasty

Ishan Kasat, BS
Thomas Jefferson University

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By Ishan Kasat, BS | Faculty Reviewer: Beeran Meghpara, MD

Overview of Keratoplasty

The evolution of corneal transplantation, or keratoplasty, has seen a paradigm shift from traditional penetrating keratoplasty (PKP) to the refined precision of lamellar keratoplasty (LK). Penetrating, or full thickness, keratoplasty is a replacement of all corneal layers: epithelium, Bowman's layer, stroma, Descemet's membrane, and endothelium.[1] Lamellar, or partial thickness, keratoplasty involves replacement of either epithelium and stroma (anterior lamellar) or Descemet's membrane and endothelium (posterior lamellar).[2] From 1985 to 2004, over 95% of graft tissues were used for PKP. However, from 2005 to 2014, the percentage of PKP procedures decreased from 95% to 42%, while LK increased from 5% to 95%.[3]

Comparing Penetrating Keratoplasty and Lamellar Keratoplasty

Penetrating Keratoplasty (PKP)

Historically, PKP was the gold standard for corneal transplantation, involving the replacement of the entire cornea with a donor graft. While successful in addressing a wide range of corneal pathologies such as infective keratitis, keratoconus, and corneal dystrophies, PKP is associated with drawbacks including prolonged visual recovery, unpredictable refractive outcomes, a higher risk of graft rejection, and the potential for intraoperative open sky complications.[4]

Lamellar Keratoplasty (LK)

Conversely, LK represents a transformative approach with distinct advantages over PKP. By selectively targeting and replacing only the affected corneal layers, LK minimizes surgical trauma, accelerates visual recovery, and reduces the risk of graft rejection.[1] The preservation of healthy tissue allows for improved biomechanical stability, often making LK the superior alternative.

Types of Lamellar Keratoplasty

Deep Anterior Lamellar Keratoplasty (DALK)

DALK involves selective replacement of the anterior corneal layers while sparing the healthy endothelium. Indications for DALK include keratoconus, stromal dystrophies, and corneal scars where the endothelium remains unaffected.[5] By preserving the endothelium, DALK decreases the risk of graft rejection and may provide improved biomechanical support.[3]

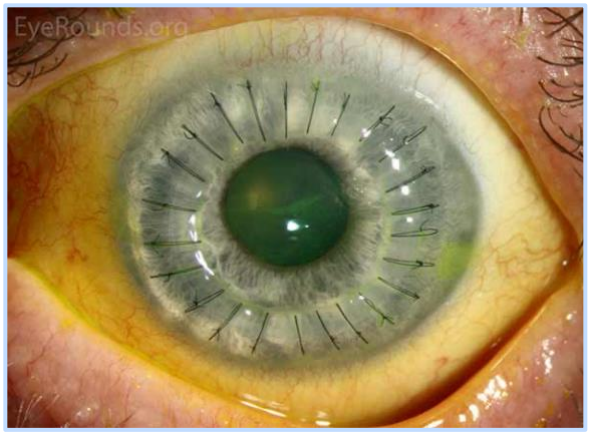

Figure 1: DALK performed for keratoconus[8]

Descemet's Stripping Automated Endothelial Keratoplasty (DSAEK)

DSAEK specifically addresses endothelial dysfunction by replacing a diseased endothelial layer and Descemet's membrane with donor endothelium, Descemet's membrane, and a small layer of posterior stroma. Indications for DSAEK include conditions such as Fuchs' endothelial corneal dystrophy and pseudophakic bullous keratopathy.[5] DSAEK offers faster visual recovery compared to PKP and reduces the risk of suture-related complications associated with full-thickness grafts. By 2014, DSAEK was the most common corneal transplant procedure performed.[3]

Descemet's Membrane Endothelial Keratoplasty (DMEK)

DMEK demonstrates the most anatomical precision, involving the transplantation of only the Descemet's membrane and endothelium using an ultra-thin graft. Indications for DMEK align with endothelial disorders, and the procedure offers superior outcomes in terms of visual acuity, refractive stability, and reduced graft rejection rates. With its clear advantages, the volume of DMEK procedures roughly doubled every year from 2011 to 2019.[3,6]

Comparison of Outcomes Between Types of Lamellar Keratoplasty

Visual Outcomes and Recovery

Both DSEK and DMEK offer faster visual recovery compared to PKP. DMEK, with its emphasis on anatomical accuracy, typically achieves the highest level of postoperative visual acuity and the fastest recovery.[3]

Refractive Outcomes

Both DSEK and DMEK exhibit more predictable refractive outcomes compared to PKP as there is less induced astigmatism. DMEK, with its thinner graft, may induce less refractive change compared to DSEK.[7]

Graft Survival and Rejection Rates

All forms of LK demonstrate reduced graft rejection rates compared to PKP.[2] The selective replacement of affected layers in lamellar procedures contributes to improved graft survival. DMEK, with its minimal tissue interface, showcases the lowest rejection rates among lamellar techniques.[3]

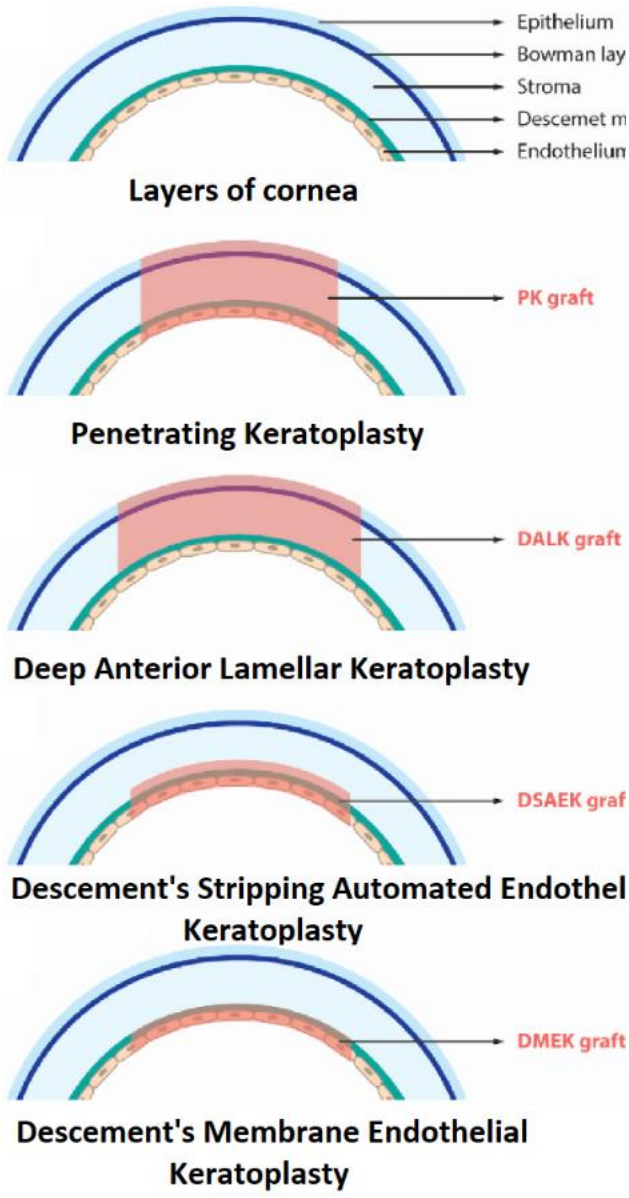

Figure 2: Types of corneal grafts and corneal transplantations

Conclusion

The evolution of lamellar keratoplasty highlights the transformation from conventional PKP to precision-tailored techniques such as DALK, DSAEK, and DMEK. Future refinements depend on advancements in imaging, regenerative medicine, and precision instrumentation. Dr. Beeran Meghpara, a corneal specialist at Wills Eye Hospital, notes, "the future of lamellar keratoplasty is bright; as procedures become more tailored, we hope to see patient outcomes and post-op visual acuity continue to improve." As ophthalmologists, understanding the nuanced differences and indications for each type of lamellar keratoplasty is crucial for reducing complications and optimizing patient outcomes.

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