Journal of Innovations in Medical Research and Clinical case Reports (JIMRCR)

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Review Article

Restoring Vision Through Precision: Advances and Outcomes in Keratoplasty

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Citation: Rothenburg R, Restoring Vision Through Precision: Advances and Outcomes in Keratoplasty V1(4), 2026

Received date: January0 5, 2026**: Accepted date:** January 10, 2026**: Published date:** January 15 ,2026
Keywords: endothelial keratoplasty, visual rehabilitation, regenerative therapies, regenerative medicine, corneal regeneration, suture management, keratoprosthesis

Abstract

Keratoplasty, commonly known as corneal transplantation, is a surgical procedure aimed at restoring vision by replacing damaged or diseased corneal tissue with healthy donor tissue. Over the decades, significant advancements in surgical techniques—from full-thickness penetrating keratoplasty (PK) to selective lamellar approaches such as deep anterior lamellar keratoplasty (DALK) and endothelial keratoplasty (EK)—have improved patient outcomes and reduced complications. This article explores the indications, types, surgical methods, postoperative care, and emerging innovations in keratoplasty. Emphasis is placed on the shift toward minimally invasive, layer-specific procedures that preserve corneal integrity while enhancing visual rehabilitation. Additionally, challenges such as graft rejection, donor shortages, and long-term graft survival are discussed alongside future directions, including bioengineered corneas and regenerative therapies.

Introduction

The cornea, the transparent anterior layer of the eye, plays a crucial role in focusing light onto the retina. Any damage or pathology affecting its clarity can significantly impair vision. Keratoplasty is a well-established surgical intervention designed to replace compromised corneal tissue, thereby restoring visual function and improving quality of life.

Indications for Keratoplasty

Keratoplasty is performed for a variety of corneal conditions, including:

- **Keratoconus (**progressive thinning and cone-shaped distortion)
- **Corneal scarring** due toss trauma or infection
- **Fuchs' endothelial dystrophy**
- **Bullous keratopathy**
- **Corneal ulcers and perforations**
- **Congenital corneal opacities**

Types of Keratoplasty

1. Penetrating Keratoplasty (PK)

This traditional method involves full-thickness replacement of the cornea. While effective, it carries higher risks of rejection and longer recovery time

2 Lamellar Keratoplasty.

Selective replacement of specific corneal layers has transformed modern corneal surgery:

- **Deep Anterior Lamellar Keratoplasty (DALK):**
  Replaces the anterior layers while preserving the patient's endothelium. Ideal for keratoconus and stromal scars.
- **Endothelial Keratoplasty (EK):**
  Focuses on replacing the innermost endothelial layer. Subtypes include:
  - **Descemet's Stripping Endothelial Keratoplasty (DSEK)**

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- **Descemet's Membrane Endothelial Keratoplasty (DMEK**

These techniques offer faster recovery, reduced rejection risk, and better structural integrity.

Surgical Procedure

Keratoplasty is typically performed under local or general anesthesia. The diseased corneal tissue is carefully excised, and donor tissue is sutured or positioned using advanced techniques such as air or gas tamponade in endothelial procedures. Precision instruments and imaging technologies enhance surgical accuracy.

Postoperative Care and Complications

Patients require close monitoring following surgery. Common aspects include:

- Use of topical corticosteroids and antibiotics
- Regular follow-up visits
- Suture management (in PK and DALK)

Potential complications:

- Graft rejection
- Infection
- Astigmatism
- Graft failure

Early detection and management are essential to ensure graft survival.

Advances in Keratoplasty

Recent innovations have significantly improved outcomes:

- **Femtosecond laser-assisted keratoplasty** for precise incisions
- **Pre-loaded donor grafts** to reduce surgical time
- **Artificial corneas (keratoprosthesis)** for high-risk cases
- **3D bioprinting and stem cell therapy** for future corneal regeneration

Challenges and Future Directions

Despite progress, challenges persist:

- Limited availability of donor corneas
- Risk of immune rejection
- Need for long-term immunosuppression

Future research is focused on developing synthetic corneas, enhancing graft survival, and reducing dependency on donor tissue through regenerative medicine

Conclusion

Keratoplasty remains a cornerstone in the management of corneal blindness. The evolution from full-thickness transplants to targeted lamellar techniques marks a significant advancement in ophthalmology. Continued innovation promises to make corneal transplantation safer, more accessible, and more effective, ultimately restoring sight to millions worldwide

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Journal of Innovations in Medical Research and Clinical case Reports (JIMRCR)

DOI:10/JIMRCR/2026/016

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