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Perspective

Understanding Corneal Healing Post-Penetrating Keratoplasty

Moscovich Yaghy*

Department of Surgery, Burdur Mehmet Akif Ersoy University, Burdur, Turkey

DESCRIPTION

Penetrating Keratoplasty (PKP), also known as corneal transplantation, is a surgical procedure performed to replace the damaged or diseased cornea with healthy donor tissue. Whether due to corneal dystrophies, trauma, or other pathologies, PKP remains one of the most common and successful forms of solid tissue transplantation worldwide. However, ensuring optimal outcomes relies heavily on the careful monitoring of corneal healing postoperatively. Corneal healing following PKP involves a complex interplay of cellular processes, including inflammation, wound healing, and tissue remodeling. Immediately after surgery, the cornea undergoes an inflammatory response characterized by the influx of immune cells and the release of cytokines and growth factors.

Subsequent phases of healing involve epithelialization, stromal remodeling, and endothelial recovery, culminating in the restoration of corneal transparency and stability. Clinical examination remains the cornerstone of assessing corneal healing after PKP. Ophthalmologists routinely evaluate patients postoperatively to monitor graft clarity, epithelial integrity, and signs of inflammation or rejection. Bio microscopic examination with slit-lamp microscopy enables detailed visualization of the corneal surface and anterior chamber, allowing for the detection of graft-host interface abnormalities, suture-related complications, and signs of graft rejection. Transparency of the corneal graft is a primary objective following PKP, indicating proper wound closure and absence of edema or inflammation. Rapid epithelial wound closure is essential for maintaining ocular surface integrity and preventing infectious complications. Proper wound apposition and stability are facilitated by secure placement and maintenance of corneal sutures, which are gradually removed during the postoperative period. Maintaining normal intraocular pressure and absence of inflammation or hyphema in the anterior chamber are indicative of adequate wound healing and graft integration.

Anterior Segment Optical Coherence Tomography (AS-OCT) provides high-resolution cross-sectional imaging of the cornea, allowing for detailed visualization of the graft-host interface,epithelial thickness, and presence of interface fluid or opacities. AS-OCT is particularly useful for detecting early signs of graft rejection or endothelial dysfunction. Confocal microscopy enables *in vivo* imaging of corneal cellular structures at a microscopic level. It allows for the assessment of keratocyte density, endothelial cell morphology, and subclinical signs of inflammation or rejection. Corneal Topography is topographic analysis provides quantitative data on corneal curvature, astigmatism, and irregularity, aiding in the evaluation of graft-host integration and corneal stability post-PKP.

Ultrasound Biomicroscopy (UBM) is valuable for assessing posterior segment complications, such as angle closure, cyclitic membranes, or intraocular lens positioning, which may impact corneal healing and visual outcomes. Clinical assessment of corneal healing is inherently subjective and may vary among practitioners. Standardized grading systems and objective metrics are needed to ensure consistency in evaluating postoperative outcomes. While imaging modalities provide valuable insights into corneal structure and morphology, they may have limitations in detecting subtle changes or early signs of graft rejection, particularly in the presence of interface opacities or irregular astigmatism.

The availability and cost-effectiveness of imaging technologies may pose barriers to widespread adoption, particularly in resource-limited settings. Efforts to improve affordability and accessibility of these modalities are essential for enhancing postoperative monitoring and patient care. Corneal healing is an ongoing process that may continue for months to years following PKP. Long-term surveillance is necessary to monitor for late complications, such as endothelial cell loss, graft failure, or recurrence of underlying corneal pathology.

Continued research and innovation in imaging technology hold potential for improving the detection and monitoring of corneal healing after PKP. Advances in Artificial Intelligence (AI) and machine learning algorithms may facilitate automated image analysis and pattern recognition, enabling early detection of graft-related complications and personalized treatment approaches.

Correspondence to: Moscovich Yaghy, Department of Surgery, Burdur Mehmet Akif Ersoy University, Burdur, Turkey, E-mail: Moscovichyaghy@gmail.com

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