Assignment #2: Research Review Article

Name: Mehrnaz Ighani

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Professor: Nicole Cuffy

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Evolving Techniques in Partial Endothelial Keratoplasty: A Comprehensive Literature Review

Mehrnaz Ighani[1]

1.Department of Community and Behavioral Health, School of Public Health, University of Maryland, College Park, Maryland, 20742

ABSTRACT

Individuals with endothelial disorders such as Fuchs' corneal dystrophy and bullous keratopathy require corneal transplantation of the diseased corneal tissue once their endothelial cell density has decreased significantly. In the past century, penetrating keratoplasty (PK) or full corneal transplantation has been the most widely used procedure to treat endothelial dysfunction. However, endothelial keratoplasty (EK) has replaced PK as it has lower post-operative complications. EK consists of Descemet's stripping endothelial keratoplasty (DSEK) and Descemet's membrane endothelial keratoplasty (DMEK). This study consists of a literature review on the advantages and disadvantages of DMEK and DSEK and their post-operative complications. Patients who undergo the DMEK procedure experience lower rates of graft rejection, more frequent re-bubbling and follow-up appointments, and faster visual recovery period. Patients who undergo the DSEK procedure have higher rates of graft rejection, longer visual recovery period, and less re-bubbling rates and follow-up appointments. Surgical techniques for repairing endothelial dysfunction are evolving, but we need larger long-term studies to prove that new techniques are superior to the current surgical techniques.

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INTRODUCTION

Endothelial keratoplasty (EK) is a corneal transplantation surgical technique that selectively replaces only the endothelial layer of the cornea (inner most layer).[1] Endothelial cells of the cornea can be destroyed due to conditions such as Fuchs'corneal dystrophy, bullous keratopathy, corneal injuries, and other endothelial disorders. We are born with a certain supply of corneal endothelial cells and endothelial cell density decreases with age. If a person reaches a low-density level, the pump action of the endothelium becomes deficient and the cornea becomes hazy, inflamed, and opaque. In the past 15 years, penetrating keratoplasty (PK) or full corneal transplantation has been replaced by EK or partial thickness corneal transplantation as PK results in higher rates of donor graft failure and rejection and infection.[1,2] EK utilizes a smaller incision size, reduces ocular surface complications, and provides faster visual recovery period, lower graft failure rates, and less refractive error post operatively.[3] In EK, the donor tissue is loaded into an inserter such as Jones tube, endoglide, or B-cartridge and injected into the anterior chamber of the cornea. After injection, the surgeon orients and unfolds the graft and adds an air bubble in the anterior chamber to support graft adherence. Some general risks and complications associated with EK are chronic inflammation, high intraocular pressure, glaucoma, retinal detachment, rejection of the transplanted tissue, double vision, and poor vision.[4]

There are two types of EK, Descemet's stripping endothelial keratoplasty (DSEK) and Descemet's membrane endothelial keratoplasty (DMEK). Introduced in 2006, DSEK replaces the dysfunctional endothelium and Descemet membrane (DM) with endothelium, DM, and

posterior corneal stroma from the donor.[5] Compared with PK, DSEK provides less post-operative complications and faster visual outcomes, but stroma-to-stroma interface variations reduce the likelihood of patients achieving 20/20 best-corrected visual acuity (BCVA) post operatively.[6] More recently, surgeons have been using the DMEK technique as it is designed to transplant the endothelium and DM, excluding any donor stroma. Given the fact that a thinner tissue is transplanted in DMEK, it provides superior visual outcomes compared with DSEK, but since the DMEK procedure is in its early stages, we need more studies on the advantages, disadvantages and complications of this technique.[7] The purpose of this review is to illustrate the progressive improvements in EK, describe the results comparing DMEK and DSEK, and discuss the complications of both techniques.

HISTORY

Over the past century, EK techniques have evolved to introduce selective tissue replacement techniques that preserve healthy corneal tissue and avoid post-operative risk associated with full thickness corneal transplantation. In 2004, Dutch ophthalmologist, Gerrit Melles, MD, introduced the idea of stripping and removing the patient's DM and endothelium with his Descemetorhexis technique and described this technique as DSEK.[2] Later, ophthalmologists Mark Gorovoy, MD and Francis Price, MD introduced simplifications, new instrumentation, and the microkeratome for automated preparation of donor cornea.[2] DSEK procedure allowed patients with endothelial disorders to achieve improved post-operative visual acuity, 20/25-20/30 range, and decreased infection rates as the procedure demands a smaller incision size and zero to few incisional sutures.[6]

In 2006, Dr. Meller described DMEK which allowed for replacement of only diseased tissue.[7] Compared with DSEK, DMEK results in faster visual recovery and greater visual acuity due to the elimination of the stroma-to-stroma interface, but since the transplanted tissue is very thin, the graft tends to become detached peripherally and patients often require re-bubbling post-operatively to promote graft adherence.[7]

CURRENT RESEARCH

Refractive Outcomes

Multiple studies have illustrated that DSEK results in a compromise of BCVA due to two main reasons. The difference in tissue thickness gradient between the periphery and the center of the graft results in refractive shift after the DSEK procedure. A study by Dupps et al[6] illustrated that patients who received a donor tissue that was thinner centrally than peripherally, had a hyperopic shift post-operatively. The study concluded that variation in central graft thickness and the curvature coefficient accounted for 86% of refractive shift[6]. Another reason for the DSEK procedure resulting in a compromise of BCVA is higher-order aberrations (HOAs) at the interface between donor and host. Since the DMEK procedure consists of the transplantation of a single layer of cells, we expect superior visual outcomes. A study by Hamzaoglu et al[8] examined and compared 100 DMEK cases with 100 DSEK cases in patients with Fuchs' corneal dystrophy. The results illustrated DSEK and DMEK patients achieved BCVA of 20/40 or better 6 months after the procedure, but the majority of DMEK patients reached BCVA of 20/25 or better compared with DSEK patients.[8]

Patient Satisfaction

Despite more frequent follow-up appointments and re-bubbling rates in the post-operative period of DMEK, patients prefer DMEK over DSEK due to superior visual acuity outcomes. In a study done by Goldich et al[9], 17 patients underwent DSEK in one eye and DMEK in the fellow eye. Patients reported higher satisfaction with DMEK and no significant difference in post-operative complications such as graft rejection and graft failure rates. Another study by Maier et al[10] investigated 10 patients who underwent DMEK in one eye and DSEK in the fellow eye. 8 patients reported DMEK as the better procedure due to shorter visual recovery and all patients assessed both procedures equally painful. In this study, 50% of DMEK procedures required re-bubbling compared with 10% of DSEK procedures.[10]

Complications

Major post-operative complications associated with EK are graft failure, re-bubbling, and graft rejection and infrequent complications include reverse unfolding of the graft, bacterial endophthalmitis, epithelial downgrowth, and blood in the interface.[11] A retrospective chart review study completed by Busin et al[12] found that 63% of DMEK cases required re-bubbling compared with 3-4% of DSEK cases. When there is a partial graft detachment in the periphery, the DMEK graft tends to fold on itself as opposed to the DSEK graft which is more rigid and zippers down on itself. Studies have shown higher rates of primary graft failure in DMEK cases due to the technical difficulty of the procedure which requires the surgeon to reorient the donor tissue in the anterior chamber multiple times during the procedure.[7] Graft rejection occurs less with DMEK as the stromal vascularization is mostly responsible in initiating rejection. Anshu et al[13] described the likelihood of having graft rejection as 1% in DMEK and 12% in DSEK in

patients with a follow-up period of 2 years. Lower rejection rates mean DMEK patients use less topical steroids which results in lower rates of steroid-induced cataract and glaucoma.

CONCLUSION

DMEK is in its early stages but becoming more popular, it is crucial for patients to have proper consultation with their surgeon to choose the appropriate procedure. The DSEK procedure is appropriate for individuals who want to minimize their post-operative visits and would be satisfied with lower visual acuity outcomes. The DMEK procedure is suitable for individuals who desire a perfect vision despite higher follow-up appointments and re-bubbling rates. There are currently other surgical techniques being developed to combine the benefits and advantages of both DMEK and DSEK. Patients with endothelial dysfunction have underwent PK in the last century, but EK has been successful by improving visual outcomes and decreasing post-operative complications.

EK consists of DMEK and DSEK, each procedure has its advantages and disadvantages. With DMEK, patients achieve 20/25 or perfect vision, have higher subjective satisfaction, and decreased rates of graft rejection. Some disadvantages of DMEK include higher re-bubbling rates, more frequent follow-up appointments, and technical difficulties experienced by the surgeon. With DSEK, patients have higher rates of graft rejection and achieve lower visual acuity outcomes, but they require less follow-up appointments and re-bubbling. We need long-term studies to prove the superiority of DMEK compared with DSEK and new surgical techniques that combine the benefits of DSEK and DMEK. Further research is necessary to discover ways to stimulate endothelial regeneration in patients with endothelial disorders without the necessity of corneal transplantation.

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