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Ophthalmic Technology Assessment

Descemet Membrane Endothelial Keratoplasty: Safety and Outcomes

A Report by the American Academy of Ophthalmology

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Purpose: To review the published literature on the safety and outcomes of Descemet membrane endothelial keratoplasty (DMEK) for the surgical treatment of corneal endothelial dysfunction.

Methods: Literature searches were last conducted in the PubMed and the Cochrane Library databases most recently in May 2017. The searches, which were limited to English-language abstracts, yielded 1085 articles. The panel reviewed the abstracts, and 47 were determined to be relevant to this assessment.

Results: After DMEK surgery, the mean best-corrected visual acuity (BCVA) ranged from 20/21 to 20/31, with follow-up ranging from 5.7 to 68 months. At 6 months, 37.6% to 85% of eyes achieved BCVA of 20/25 or better and 17% to 67% achieved BCVA of 20/20 or better. Mean endothelial cell (EC) loss was 33% (range, 25%−47%) at 6 months. Overall change in spherical equivalent was +0.43 diopters (D; range, −1.17 to +1.2 D), with minimal induced astigmatism of +0.03 D (range, −0.03 to +1.11 D). The most common complication was partial graft detachment requiring air injection (mean, 28.8%; range, 0.2%−76%). Intraocular pressure elevation was the second most common complication (range, 0%−22%) after DMEK, followed by primary graft failure (mean, 1.7%; range, 0%−12.5%), secondary graft failure (mean, 2.2%; range, 0%−6.3%), and immune rejection (mean, 1.9%; range, 0%−5.9%). Overall graft survival rates after DMEK ranged from 92% to 100% at last follow-up. Best-corrected visual acuity after Descemet's stripping endothelial keratoplasty (DSEK) ranged from 20/34 to 20/66 at 9 months. The most common complications after DSEK were graft detachment (mean, 14%; range, 0%−82%), endothelial rejection (mean, 10%; range, 0%−45%), and primary graft failure (mean, 5%; range, 0%−29%). Mean EC loss after DSEK was 37% at 6 months.

Conclusions: The evidence reviewed supports DMEK as a safe and effective treatment for endothelial failure. With respect to visual recovery time, visual outcomes, and rejection rates, DMEK seems to be superior to DSEK and to induce less refractive error with similar surgical risks and EC loss compared with DSEK. The rate of air injection and repeat keratoplasty were similar in DMEK and DSEK after the learning curve for DMEK. *Ophthalmology 2017;■:1−16 © 2017 by the American Academy of Ophthalmology*

The American Academy of Ophthalmology prepares Ophthalmic Technology Assessments to evaluate new and existing procedures, drugs, and diagnostic and screening tests. The goal of an Ophthalmic Technology Assessment is to review systematically the available research for clinical efficacy, effectiveness, and safety. After appropriate review by all contributors, including legal counsel, assessments are submitted to the Academy's Board of Trustees for consideration as official Academy statements. The purpose of this assessment by the Ophthalmic Technology Assessment Committee Cornea and Anterior Segment Disorders Panel is to review the published literature on safety and outcomes of Descemet membrane endothelial keratoplasty (DMEK) to treat corneal endothelial dysfunction.

Background

Descemet membrane endothelial keratoplasty is a variation of endothelial keratoplasty for the treatment of corneal endothelial dysfunction. The concept of DMEK was introduced in 2002,[1] and the first case of DMEK use was published in 2006.[2] According to the 2015 Eye Banking Statistical Report by the Eye Bank Association of America,[3] there has been an increase in DMEK

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procedures since 2012 in the United States. There was a 64% increase in the number of DMEK procedures performed in 2015 compared with 2014, resulting in a total of 4694 DMEK procedures in 2015. There has been a 4.1% decrease in Descemet's stripping endothelial keratoplasty (DSEK) procedures since 2013, resulting in a total of 22 514 DSEK procedures in 2015. The increases in the number of DMEK procedures seems to coincide with the ability of the eye banks to offer prestripped DMEK tissues, a rapidly growing body of peer-reviewed literature, and extensive DMEK educational and skill transfer courses. Despite the difficult learning curve for the DMEK procedure, more corneal surgeons have started the transition from DSEK to DMEK since 2012 because of the purported advantages of DMEK over DSEK.

Endothelial keratoplasty has evolved rapidly since the 1990s. It was first described in 1956 as posterior lamellar keratoplasty, whereby an anterior approach was used to replace the posterior corneal lamella using sutures.[4] The technique was modified by Melles et al,[5] and later by Terry and Ousley,[6] to use a posterior approach and make a large scleral incision. The lamellar dissection of both the donor and recipient tissues was performed manually, and the donor lenticule was fixated onto the posterior stromal pocket using an air bubble instead of sutures. The manual dissection of the patient's posterior cornea proved to be too difficult to be adopted widely by corneal surgeons, and a variety of modifications were developed to improve the technique. Two modifications in particular since 2006 helped to improve and popularize the surgical procedure: (1) manual dissection of the posterior stroma was replaced with removal of the Descemet membrane (DM) from the recipient in a process described by Melles et al[7] as *descemetorhexis*, and (2) manual dissection of donor tissue was replaced using the automated microkeratome starting in 2006.[8,9] The procedure then was named Descemet's stripping automated endothelial keratoplasty and is generally referred to as DSEK, although the vast majority of donor tissues are now prepared by automated microkeratomes.

An assessment on the safety and outcomes of DSEK by the American Academy of Ophthalmology in 2009[10] concluded that DSEK was superior to penetrating keratoplasty (PK) in terms of earlier visual recovery, refractive stability, refractive outcomes after surgery, wound- and suture-related complications, and suprachoroidal hemorrhage risk during and after surgery. Descemet's stripping endothelial keratoplasty was found to be comparable with PK in terms of surgical risks, complication rates, graft survival (clarity), visual acuity (VA), and endothelial cell (EC) loss. Validation of the quality of precut tissues from eye banks further eliminated a major hurdle for most corneal surgeons who perform DSEK, and it became the surgical treatment of choice for corneal endothelial dysfunction. The number of DSEK procedures performed increased annually, and at the height of DSEK popularity (2013) the total number reached 23 465, accounting for 48.6% of all corneal transplantations performed in the United States.[3]

Since the publication of the assessment by the American Academy of Ophthalmology in 2009, information on the long-term safety and outcomes of DSEK has become available. Although DSEK provides more rapid and predictable visual recovery than PK, the best-corrected VA (BCVA) after DSEK often is limited to 20/30 to 20/40. One study reported that only 20% of eyes with Fuchs' endothelial corneal dystrophy without other corneal pathologic features achieved 20/20 or better vision at year 5.[11] A growing reason for DSEK regrafting was unsatisfactory BCVA relative to the visual potential.[12] Interface opacity, irregularity of the posterior stroma, higher-order aberration of the posterior surface, and uneven cuts of the donor tissue contributed to the decreased optical quality.[13,14]

The concept of transplanting only the DM (i.e., DMEK) was introduced in 2002 by Melles et al.[1] In DSEK, the endothelium, DM, and a thin layer of posterior stroma are transplanted as a single lamellar graft onto the surface of the host posterior stroma after descemetorhexis. In contrast, only the endothelium and DM are transplanted in DMEK. The thickness of the DM in adults (age range, 20−69 years) ranges from 6 to 15 μm, whereas the average graft thickness of tissues used in DSEK is 100 to 200 μm. Attachment of the DM graft to the posterior stromal surface may account for faster visual recovery, and it eliminates the issues of interface irregularity and haze as well as the refractive effect from the uneven stromal thickness of the microkeratome-cut DSEK graft. In the first small case series published in 2008,[15] 3 of the 7 patients achieved a BCVA of 20/20 and 6 achieved a BCVA of 20/40 or better at 1 month after successful DMEK. The speed of visual recovery substantially was faster than that reported for DSEK, and this result was confirmed by subsequent larger series.[16,17]

Donor tissues for DMEK can be prepared in several ways. The initial technique to obtain DM grafts used a 9.0-mm trephine to obtain a cut in the DM. This 9.0-mm DM was peeled off from the posterior stroma using forceps.[2] The submerged cornea using backgrounds away technique described in 2009[17] consisted of the following steps. First, the peripheral DM just inside the trabecular meshwork was scored using forceps, a Sinskey hook, or a blade. A single nontooth forceps then was used to peel the DM from the stroma approximately halfway to the center for 360° while submerged in a viewing chamber to enhance the visualization of the DM.[17] Finally, the DM was trephined to an appropriate size, and separation of the DM from the donor tissue was completed. Peeling the DM with 2 forceps reportedly reduced tension and thereby presumably reduced tears in the donor DM.[18]

Other methods using hydrodissection, pneumodissection, and viscoelastics to separate the DM have been tested in the laboratory, but are not used commonly in actual tissue preparation for transplantation in the United States. The overall failure rate of DM donor preparation by the eye banks is approximately 5%[19] and is as low as 2% when the preparation is carried out by experienced surgeons.[20] A history of diabetes mellitus may increase the failure rate of donor preparation.[21] When completely separated from the stroma, the DM tissue curls into a scroll with the endothelium facing outside. Trypan blue is used to stain the DM for visualization just before loading it into the intraocular delivery device.