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The Influence of Pre-operative Donor Tissue Characteristics on Graft Dislocation Rate after Descemet's Stripping Automated Endothelial Keratoplasty

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Abstract

PURPOSE—To determine the influence of pre-operative donor tissue characteristics on the graft dislocation rate after Descemet's stripping automated endothelial keratoplasty (DSAEK).

METHODS—We retrospectively analyzed associations between donor tissue characteristics and graft dislocation rates for consecutive DSAEK surgeries performed in a four year period at a single institution.

RESULTS—From June 2007 to June 2011, 64 (18%) of 355 eyes underwent a procedure for graft dislocation. There were no differences in donor age, pre-operative endothelial graft thickness, pre-processing endothelial cell density, change in endothelial cell density after processing, time from death to tissue processing, or time from tissue processing to surgery between eyes that experienced dislocations and those that did not ($P > .05$ for each). The graft recipient's corneal disease diagnosis, pre-operative corneal thickness, pre-operative visual acuity, glaucoma status, history of glaucoma surgery, and cataract surgery at the time of DSAEK were not associated with an increased rate of dislocation ($P > .05$ for each). Recipients who experienced graft dislocation were significantly older (73.6 vs. 70.2 years, $P = .03$) and more likely to undergo subsequent repeat transplantation (29.7% vs. 10.7%, $P < .0001$).

CONCLUSIONS—We found no correlation between any corneal donor tissue characteristic and graft dislocation after DSAEK. Graft dislocation was more common in older recipients. Patients with dislocation had a higher rate of subsequent transplantation.

Keywords

endothelial keratoplasty; dislocation; rebubble; donor characteristics

Introduction

Descemet's Stripping Automated Endothelial Keratoplasty (DSAEK) has rapidly become the preferred alternative to penetrating keratoplasty for the surgical treatment of corneal

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endothelial disease due to its smaller incision size, faster visual rehabilitation, and minimal induction of astigmatism and refractive shift.¹⁻³ Post-operative dislocation of the donor endothelial graft remains one of the most common complications of DSAEK with a mean reported rate of 14% but with large variation between studies.^{1,2,4-8} Recipient factors including previous incisional glaucoma surgery,^{9,10,11} previous penetrating keratoplasty,¹² aphakia,^{13,14} prior vitrectomy,¹⁵ and the presence of an anterior chamber intraocular lens¹⁶ have been shown to increase the rate of donor dislocation. Treatment of graft dislocation often requires a rebubble procedure, in which sterile air is injected into the anterior chamber to promote graft adherence,⁷ which may increase the risk of endothelial failure.⁶

While it has been reported that a wide range of donor characteristics can result in excellent adhesion of the tissue with clear grafts,¹⁷ we sought to evaluate if any donor characteristics were associated with graft dislocation after DSAEK; avoidance of those characteristics could improve clinical outcomes.

Materials and Methods

This retrospective study was granted Institutional Review Board approval by the University of Michigan. We included consecutive eyes that underwent DSAEK alone as well as DSAEK combined with simultaneous phacoemulsification cataract surgery at the Kellogg Eye Center, University of Michigan, Ann Arbor, MI, USA from June 2007 to June 2011. Six surgeons performed the surgeries using pre-cut donor tissue from the Midwest Eye-Banks. No surgeons requested any specific characteristics for corneal donor tissue. The eye bank standard for pre-cut tissue thickness was 250 μ m. Surgical technique, including donor lenticule insertion, varied between the surgeons, however all patients were kept in the recovery area lying supine for at least 1 hour postoperatively and were checked for graft adherence. If the graft was dislocated, rebubble procedure was performed that same day.

From the Midwest Eye-Banks' Midwire database, we obtained the following information: donor age, pre-processing donor corneal thickness, post-processing lamellar thickness, pre-processing endothelial cell density, post-processing endothelial cell density, time from death to tissue processing, and time from tissue processing to surgery. Corneal lamellar tissue processing was performed at the Michigan Eye Bank by a certified technician using a standardized protocol.¹⁸ Endothelial tissue for transplantation is typically prepared the day before the surgery is planned. Endothelial graft thickness was measured with ultrasound pachymetry (Pachette 2, DGH Technology Inc., Exton, PA) immediately after the microkeratome pass. After lamellar dissection, the free anterior cap was replaced and the tissue was placed in the viewing chamber stored in Optisol GS (Bausch & Lomb, St. Louis, MO). Endothelial cell density was measured with a specular microscope (KeratoAnalyzer EKA-10, Konan Medical Inc., Irvine, CA)

From the medical records of each recipient we recorded age, gender, corneal diagnosis, pre-operative central corneal thickness measured by ultrasound pachymetry, pre-operative best spectacle corrected distance visual acuity (BCVA), post-operative BCVA at one year and last follow up, presence of visually significant ocular co-morbidities, history of glaucoma, prior incisional glaucoma surgery (i.e., trabeculectomy or glaucoma tube implant), occurrence of graft dislocation, and need for repeat transplantation. Graft dislocation was defined as non-adherence of the donor graft to the recipient requiring surgical intervention with a rebubble technique either in the operating room or a procedure room in clinic either on the same day or a subsequent day. If an eye underwent multiple graft relocation procedures, the patient and event were only included once in the analysis.

The associations between donor tissue characteristics and the primary outcome of graft dislocation were examined. For sub-analyses with visual acuity as an outcome, only eyes with greater than 3 months of follow up were included. Eyes were excluded if they underwent a subsequent transplant or had vision-limiting comorbidities including macular pathology, advanced glaucoma, and optic nerve pathology thought to have an effect on acuity. Snellen acuity was converted to logarithm of the minimum angle of resolution (logMAR) for statistical analysis. Statistical analysis was performed using SAS 9.3 (Cary, NC) with two-tailed t-tests, Pearson correlation coefficients, and Chi square analysis. A P value <.05 was considered significant.

Results

Three hundred fifty-five eyes of 277 patients were included, with 199 (56%) right eye surgeries and 156 (44%) left eye surgeries. One hundred fifty-eight (57%) patients were female and 119 (43%) were male. Two hundred sixty-two (82%) eyes underwent DSAEK alone while 64 (18%) eyes underwent DSAEK combined with cataract surgery. The indication for transplant was Fuchs' dystrophy in 204 (58%) eyes, pseudophakic or aphakic bullous keratopathy in 86 (24%) eyes, failed DSAEK in 34 (10%) eyes, failed PKP in 27 (8%), and other diagnoses in 4 (1%) eyes. Seventy-one (20%) eyes had a diagnosis of glaucoma, with 37 (10%) having prior incisional glaucoma surgery. One hundred eighty-four eyes had at least 3 months of postoperative follow up and were without vision limiting co-morbidities. In these eyes, vision improved from logMAR 0.47 ± 0.30 (Snellen equivalent 20/59) pre-operatively to 0.16 ± 0.13 at the last post-operative visit (Snellen equivalent 20/29, $P < .0001$).

Sixty-four (18.0%) eyes underwent a rebubble procedure for a dislocated graft, of which 19 (29.7%) required a subsequent corneal transplant. Thirty-one (10.7%) eyes that did not undergo a rebubble procedure required a subsequent transplant ($P < 0.0001$). The rate of dislocation was not significantly different between eyes that underwent DSAEK alone versus DSAEK combined with cataract surgery (19.8% vs 13.0%, $P = 0.14$). The rate of dislocation was not associated with recipient corneal diagnosis ($P = 0.38$), a history of glaucoma ($P = 0.68$), or prior incisional glaucoma surgery ($P = 0.88$). Neither the presence of a glaucoma drainage device ($P = 0.44$) nor prior trabeculectomy ($P = 1.0$) were significantly associated with the rate of dislocation. Table 1 compares the characteristics and visual outcomes of eyes that required a graft dislocation procedure versus those that did not. Excluding eyes that underwent subsequent repeat transplant, BCVA at 1 year and last follow up was not significantly different between eyes that underwent a rebubble procedure and those that did not. Only recipient age was significantly different between the two groups, with older patients more likely to experience a DSAEK graft dislocation ($P = .03$).

A multiple logistic regression model showed no significant association of DSAEK dislocation with donor age, death to processing time, processing to surgery time, post-cut lamellar corneal thickness, post-processing endothelial cell density, recipient age, recipient pre-operative corneal thickness and pre-operative visual acuity ($P = 0.93$).

Discussion

We found no correlation between any corneal donor tissue characteristic and the primary outcome of graft dislocation after DSAEK. Graft dislocation was associated with older recipient age, but not with pre-operative corneal diagnosis, pre-operative BCVA, pre-operative corneal thickness, diagnosis of glaucoma, or prior incisional glaucoma surgery. Eyes that experienced a dislocation event were more likely to undergo subsequent corneal transplantation than those that did not.

Low dislocation rates in one study precluded determination of statistical correlation between donor tissue characteristics and outcomes.¹⁷ Terry et al. reported no correlation between pre-operative endothelial cell density and graft dislocation.¹⁹ Factors related to endothelial cell viability, for example the time from donor death to implantation, could affect endothelial pump function and influence surgical outcomes. Our results do not support this hypothesis. In a small study of 71 eyes, Demsey and Baxter reported no significant difference in time between death and tissue procurement, procurement and processing, and time spent in storage between eyes with dislocations and those that remained attached.²⁰ Additionally, it has been suggested in non-peer reviewed publications that in eye bank prepared grafts donor tissue swelling from prolonged contact between the exposed stroma and the dextran component of Optisol media could reduce graft adhesion, but we found no correlation between dislocation events and the time from DSAEK tissue processing (i.e. eye bank pre-cut procedure) to surgery. Since the eye bank only uses one type of storage media, we could not make conclusions regarding the influence of media type on dislocation events. In Descemet's membrane endothelial keratoplasty (DMEK) it has been reported that donor tissue culture conditions affect dislocation, with those grafts stored in Optisol having a higher rate of dislocation compared to grafts stored in organ culture.²¹

Overall, our dislocation rate is consistent with previously reported rates, given our distribution of pre-operative diagnoses, ocular co-morbidities, inclusion of initial cases in the "learning curve," and involvement of clinical fellows in surgical training. Of note, it has been reported that results and complications of DSAEK performed by supervised novice fellows are similar to those of an experienced DSAEK surgeon.²² Our graft dislocation rate was not significantly different between cases of DSAEK alone compared to DSAEK performed with cataract surgery, consistent with results reported in a similar sized cohort by Terry et al.²³

In accordance with previous reports, the majority (70%) of dislocated grafts in our study were successfully re-attached after additional procedures,^{24,25} with no deleterious effect on visual acuity.²⁶ However, in our study grafts that required a dislocation procedure were more likely to undergo subsequent repeat transplant.

Of the recipient factors examined in our study, only age was correlated with dislocation rate. To our knowledge this relationship has not been previously reported. Neither pre-operative central corneal edema nor pre-operative BCVA, both of which could indicate the severity of endothelial disease, influenced donor adherence. Additionally, dislocation rate was not associated with recipient corneal diagnosis. In contrast to prior reports,⁹⁻¹¹ we did not find an association of history of glaucoma or prior incisional glaucoma surgery with a higher rate of graft dislocation.

There are certain limitations to our study. Retrospective analyses do not allow for randomization of donor characteristics or standardization of recipient risks factors. This cohort included patients of six corneal surgeons with individual variations in surgical technique; although this increases variability in our study, it could also increase the generalizability of our findings. We did not include all partial dislocations, only those clinically significant enough to warrant a rebubble procedure. As has recently been described for DMEK,²⁷ awaiting spontaneous clearance may be advisable in eyes with a partial detachment after DSAEK. At our eye bank, donor tissue is typically prepared the day before surgery, so although our study did not reveal an association of time from processing to surgery with graft dislocations, we are limited by the eye bank's specific policies and procedures. We cannot comment on whether longer storage of prepared lamellar tissue would be associated with graft dislocation.

In summary, we found no correlation between any corneal donor tissue characteristic and graft dislocation after DSAEK. Older recipients were more likely to experience graft dislocation. Patients who experienced graft dislocation were more likely to need repeat corneal transplantation. Intrinsic biological and physiological recipient factors and surgical technique appear to affect graft attachment more than the evaluated pre-operative donor tissue characteristics.

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Table 1

Characteristics associated with graft dislocation procedure

	No graft dislocation procedure		Graft dislocation procedure needed		
Donor Variables	N	Mean $\pm$ SD	N	Mean $\pm$ SD	P value
Donor age (years)	291	57.32 $\pm$ 11.16	64	57.95 $\pm$ 11.96	0.68
Death to processing (days)	291	3.50 $\pm$ 1.14	64	3.35 $\pm$ 1.18	0.35
Processing to surgery (days)	291	0.49 $\pm$ 0.29	64	0.54 $\pm$ 0.27	0.23
Pre-cut ECD (cells/mm ²)	291	2816.2 $\pm$ 270.36	64	2768.22 $\pm$ 261.90	0.20
Post-cut ECD (cells/mm ²)	291	2806.77 $\pm$ 253.24	64	2807.31 $\pm$ 295.56	0.99
Pre-cut donor thickness (μ m)	291	557.83 $\pm$ 46.96	64	556.22 $\pm$ 42.62	0.80
Post-cut lamellar thickness (μ m)	291	168.05 $\pm$ 41.76	64	172.13 $\pm$ 41.60	0.48
Recipient variables					
Recipient age (years)	288	70.19 $\pm$ 11.30	64	73.58 $\pm$ 10.26	0.03
Pre-operative corneal thickness (μ m)	214	708.45 $\pm$ 99.83	49	714.39 $\pm$ 100.60	0.71

SD = standard deviation; ECD = endothelial cell density