RESEARCH

Descemet's Stripping Automated Endothelial Keratoplasty Using Donor Tissue From Donors With a History of Laser In Situ Keratomileusis or Photorefractive Keratectomy

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ABSTRACT

Purpose: To identify prevalence of post refractive donor corneal tissue in the donor pool, utilization rate, and rate of complications compared to tissue from donors without previous refractive surgery.

Methods: We obtained data on prevalence and utilization of post-refractive cornea donor tissue from donor records at the Utah Lions Eye Bank (ULEB) from 2009-2012. Procurement and utilization rates of post-refractive donor tissue were compared to rates in the ULEB annual reports for non-refractive donor tissue. The incidence of primary graft failure in Descemet's stripping automated endothelial keratoplasty (DSAEK) grafts and tissue loss during processing were analyzed.

Results: Between 2009 and 2012, 125 donor corneas were procured by the Utah Lions Eye Bank from donors that had undergone prior refractive surgery (i.e. laser in situ

keratomileusis, LASIK, or photorefractive keratectomy, PRK). Of these 125 donor corneas, 45 were suitable for tectonic grafting only due to inadequate endothelial counts. Of the remaining 80 donor corneas intended for transplantation, 65 were used for DSAEK, 12 expired before utilization, 2 were rejected by the operating surgeon on the basis previous refractive surgery, and 1 cornea was damaged during preparation for DSAEK. One case of primary graft failure was reported. No other tissue related complications related to post refractive donor tissue were reported.

Conclusions: LASIK and PRK donor tissue appears to be safe and effective in DSAEK and would likely be acceptable for DMEK. Utilization of tissue from post refractive patients will increase in importance as this tissue becomes more prevalent in the donor pool.

KEYWORDS

DSAEK; LASIK; PRK; endothelial keratoplasty (EK)

INTRODUCTION

In 2007 the number of LASIK cases in the United States reached a peak volume of 1.4 million.[1] Although the popularity of refractive surgery varies from year to year, the overall prevalence of patients that have undergone LASIK and/or surface ablation (PRK, LASEK) continues to increase. In 2012, the *Eye Bank Association of America* (EBAA) *Statistical Report*, prior refractive surgery was listed as a reason tissue intended for surgery was not suitable for transplant.[2] That year's statistical report documented that of the 30,185 eyes/corneas intended for transplantation but not released for transplant, 298 eyes/corneas (1.0%) had undergone prior refractive surgery. The impact on the donor pool to date has been relatively minor, but as higher numbers of post refractive eyes enter the donor pool, a more profound the impact on tissue utilization can be expected. Further threating the donor supply is an increase in the elimination of potential donors due to risk of communicable disease such as hepatitis B and C, West Nile Virus, prion disease, and perhaps fungal keratitis.[3,4] Despite a keen interest in developing a biosynthetic cornea as an alternative for cornea transplantation, no alternatives have yet been brought to market.[5,6] It is also important to note that though surgeons within the United States currently enjoy ready access to quality donor corneal tissue, there is still a shortage of transplant quality tissue internationally.

Fortunately, the widespread acceptance of endothelial keratoplasty (EK) techniques allows for utilization of donor tissue previously considered unacceptable for traditional corneal transplantation. A growing number of reports have shown that tissue from donors that have undergone LASIK or PRK can be successfully utilized in DSAEK.[7,8,9]

The *Eye Bank Association of America 2012 Annual Report*, containing the most up to date statistics on donor procurement and utilization, shows that the number of corneas utilized for EK (23,049) increased 6.6% from 2011, while the number of penetrating keratoplasty (PKP) grafts decreased 0.9% from 2011 to 21,422, marking the first time EK procedures have surpassed PKP as the primary technique for cornea transplantation.[2]

Currently there is limited information in the literature reporting the prevalence of LASIK and PRK donor tissue in the donor pool or complications related to procedures utilizing such tissue compared to donor tissue not obtained from LASIK or PRK donors. We report the prevalence of LASIK and PRK tissue in the donor pool for the Utah Lions Eye Bank as well as complications related to DSAEK cases utilizing this tissue.

MATERIALS AND METHODS

IRB approval was obtained to review donor records from 2009-2012 for the Utah Lions Eye Bank. Donors that had undergone prior refractive surgery were identified by medical history as well as biomicroscopic examination of the donor tissue before tissue release for transplantation. Prior to 2009, refractive surgery was considered a contraindication for donation at the Utah Lions Eye Bank (with limited exceptions on a case by case basis starting in 2008). Recipient records for transplanted tissue were reviewed for the same period. Adverse events reported by transplant surgeons and tissue loss due to processing errors for donor tissue released for DSAEK were reviewed. Differences in the complication rates during donor preparation for DSAEK were compared used chi-square analysis and Fisher's exact test.

RESULTS

Between 2009 and 2012, 125 donor corneas (32 in 2009, 34 in 2010, 24 in 2011, and 35 in 2012) were procured by the Utah Lions Eye Bank from donors that had undergone refractive surgery (i.e. LASIK or PRK). Of these 125 donor corneas, 45 were determined to be suitable for tectonic grafting only due to inadequate tissue characteristics. Of the remaining 80 donor corneas intended for transplantation, 65 were successfully used for DSAEK, 12 expired before utilization, 2 were rejected by the operating surgeon on the basis previous refractive surgery, and 1 cornea was damaged during preparation for DSAEK (**Figure 1)**. Only 1 case of primary graft failure was reported. No other tissue related complications attributable to post refractive donor tissue were reported.

The one processing error occurred during processing of tissue from a post-LASIK donor. A small donor rim was noted during placement of the donor tissue in the anterior chamber maintainer and suction was lost during passage of the microkeratome. The single case of primary graft failure occurred in a surgeon prepared donor cornea from a donor that had undergone previous LASIK. Preoperatively the donor endothelial cell density was 3039. Prominent folds in the donor lenticle were noted at postoperative day one. These folds persisted at all subsequent follow up visits despite rebubbling and manipulation with a flap roller. Though the cornea cleared and the lenticle remained adherent, the folds persisted and BCVA was never better than 20/70 at six months. The recipient underwent repeat DSAEK due to a suboptimal visual outcome. The repeat DSAEK was uneventful and the recipient achieved BCVA of 20/20 at 12 months.

Between 2009 and 2012 the Utah Lions Eye Bank procured 6,894 donor eyes (1204 in 2009, 1535 in 2010, 2005 in 2011, and 2150 in 2012) through local recovery and imported tissue (**Table 1)**. For the purposes of statistical analysis, tissue designated for research was not included (this tissue was not considered suitable for transplantation). Of the 6,894 donor eyes procured, 4,156 were intended for transplantation (911 in 2009, 1071 in 2010, 1090 in 2011, and 1084 in 2012). The total number of tissue processing errors during surgeon preparation of donor tissue for DSAEK from 2009-2012 was 17 out of 600 attempts. The number of tissue related DSAEK primary graft failures over this same time period was zero.

Corneas from donors that had previously undergone LASIK or PRK accounted for 3.1% of donor tissue intended for transplant from 2009-2012 at the Utah Lions Eye Bank. Post refractive donor tissue accounted for 11% of all tissue used for DSAEK from 2009-2012 (**Figure 2**). The complication rate during surgeon preparation of post refractive donor tissue for DSAEK was 1.5% (1 in 66 attempts) compared to a complication rate of 2.8% (17 in 600 attempts) in non-refractive donors, which was not statistically significant (P=1.00). It is important to note that the John A. Moran Eye Center does have a fellowship training program and cornea fellows are trained in tissue processing for endothelial transplant. The one processing error that occurred was in attending prepared tissue however. The overall complication rate for donor tissue with prior refractive surgery was 3% (2 per 66 cases).

During the time period reviewed the Utah Lions Eye Bank utilized the services of Lions Vision Gift Eye Bank (LVG; Portland, Oregon) to supply precut DSAEK tissue when

requested by non-university transplant surgeons in our distribution network. The LVG complication rate was 4.4%, or 5 failures in 113 attempts, during technician preparation of post-refractive donor tissue from 2009 to 2012. The LVG complication rate for donors without previous refractive surgery was 1.6% or 72 failures in 4519 attempts (personal communication). A comparison of cut-rate failure for post-refractive tissue prepared by the LVG and our study group from the Moran Eye Center shows no statistically significant difference (P=0.42).

DISCUSSION

LASIK and PRK continue to enjoy widespread popularity. In the future it will become increasingly more common to encounter potential cornea donors that have undergone refractive surgery. As the percentage of these donors grows in the donor pool, it will become important to find ways to appropriately utilize this tissue. Currently there is a very limited body of knowledge in regards to the utilization of cornea tissue from donors that have undergone LASIK, PRK, or other forms of surface ablation. This may be due to the fact that the current supply of tissue for corneal transplantation is sufficient that transplant surgeons have little need to utilize this tissue. It also may be due to limited experience with post refractive tissue processing for DSAEK or concerns about tissue quality following refractive procedures.

Several case series have evaluated the effects of excimer laser refractive surgery on corneal endothelium. Smith *et al* compared the effects of thin flap LASIK and PRK on endothelial cell density in 25 patients.[10] They noted no significant change in endothelial cell density following either procedure and no significant difference between the two groups out to 3 months postoperatively. Patel and Bourne evaluated long term changes

in corneal endothelium of 29 eyes following LASIK.[11] They found that at 9 years endothelial cell density decreased by 5.3%, but there was no significant change in coefficient of variation of cell area or percentage of hexagonal cells, and the annual rate of cell loss was no different in post-LASIK corneas than in normal corneas.

Previous research has established that tissue not deemed suitable for full thickness PKP can be successfully used for endothelial keratoplasty. Phillips *et al* performed DSAEK using 42 anterior stromal flawed (ASF) donor corneas not considered suitable for PKP according to the EBAA criteria.[7] Of these 42 donors, 29 had anterior scars, 7 had previous LASIK, 2 had previous RK, 2 had pterygium, and 1 had RK followed by LASIK. The results of DSAEK procedures performed using ASF donor tissue was compared with a DSAEK control group. No difference was found in visual acuity, topography, astigmatism, pachymetry, or ECD. Notably, Phillips *et al* did report one case of intraoperative perforation of the donor tissue prior to insertion.

Moshirfar *et al* have made several suggestions to appropriately identify and utilize tissue from donors that have undergone LASIK or PRK, including: appropriate screening of tissue by history and clinical evaluation, initiating the microkeratome pass at the hinge site, maintaining adequate pressure in the chamber without overinflating, and careful inspection of flap architecture.[9]

Previous authors have described optical phenomena that may result from microkeratome preparation of the DSAEK donor lenticle and subsequently impact vision. Hyperopic shift induced by non-uniform lenticle thickness and low ratio of central to peripheral cut thickness, creation of asymmetrical cylindrical astigmatism at the posterior cornea, and elliptical lenticle shape may contribute to compromised visual acuity.[12,13,14]

These phenomena may be compounded in DSAEK using LASIK or PRK donor tissue

since the punch is usually performed at the geographic center of the cornea while most refractive procedures are centered over the pupil. These issues might be less significant if LASIK and PRK donor tissue were used for Descemet's membrane endothelial keratoplasty (DMEK).

The Utah Lions Eye Bank has been using corneal tissue from donors that have undergone LASIK or PRK since 2009 and on a case by case basis since as early as 2008. We feel that tissue from donors that have undergone LASIK or PRK is appropriate for DSAEK based on the low rate of surgeon processing errors and low rate of primary failure. Our experience with preparation of post-refractive donor tissue from LASIK and PRK donors has led us to several insights that may be of assistance during tissue preparation for DSAEK. First, it is important to obtain a regular, 3-4 mm scleral rim during procurement of the donor tissue. A meticulous technique should be employed during cutting, including: careful inspection of the donor to confirm a well healed flap, identification of the hinge, and initiation of the microkeratome pass at the hinge to decrease the chance of flap dehiscence during cutting. We agree with Moshirfar *et al*[9] that it is important to tighten the anterior chamber maintainer carefully before pressurization, avoid overpressurization, and retighten before the microkeratome pass.

Cornea tissue from donors that have undergone LASIK and/or PRK appears to be safe and effective for DSAEK. We find no difference in the rate of primary failure of grafts from refractive surgery patients compared to grafts from patients that have not undergone refractive surgery. Similarly we found no difference in the incidence of tissue processing errors between donor tissue from post refractive donors and tissue obtained from donors

without prior refractive surgery. It is probable that post refractive donor tissue (i.e. LASIK and PRK) can be used with the same safety and efficacy in DMEK as well. As post refractive patients begin to make up a greater percentage of the donor pool, improving the utilization of post refractive donor corneas will become increasingly important.

REFERENCES

1. US Refractive Surgery Quarterly Updates. *Market Scope*.

2. Eye Bank Association of America. 2012 Eye Banking Statistical Report. 2013.

3. Van Meter W, Sheth PH. Potential adverse effects on the donor cornea pool in 2031. International Journal of Eye Banking 2013 Feb 1(2):1-9

4. Aldave AJ, DeMatteo J, Glasser DB, Tu EY, Iliakis B, Nordlund ML, Misko J, Verdier DD, Yu F. Report of the Eye Bank Association of America medical advisory board subcommittee on fungal infection after corneal transplantation. Cornea 2013 Feb 32(2):149-154.

5. Fagerholm P, Lagali NS, Merrett K, et al. A biosynthetic alternative to human donor tissue for inducing corneal regeneration: 24-month follow-up of a phase 1 clinical study. *Science Translational Medicine*. 2010;2(46):46-61.

6. Orwin EJ, Borene ML, Hubel A. Biomechanical and optical characteristics of a corneal stromal equivalent. *Journal of Biomechanical Engineering*. 2003;125(4):439-444.

7. Philips PM, Terry MA, Shamie N, Chen ES, Hoar KL, Stoeger C, Friend DJ, Saad HA. Descemet's stripping automated endothelial keratoplasty (DSAEK) using corneal donor tissue not acceptable for use in penetrating keratoplasty as a result of anterior stromal scars, pterygia, and previous corneal refractive surgical procedures. Cornea. 2009 Sep 28(8):871-876.

8. Armour RL, Ousley PJ, Wall J, Hoar K, Stoeger C, Terry MA. Endothelial keratoplasty using donor tissue not suitable for full-thickness penetrating keratoplasty.

Cornea. 2007 Jun 26(5):515-519.

9. Moshirfar M, Khalifa YM, Davis D, Fenzi CR, Espandar L, Chang JC, Mamalis N, Mifflin MD. Descemet's stripping automated endothelial keratoplasty (DSAEK) using corneal donor tissue not acceptable for use in penetrating keratoplasty as a result of anterior stromal scars, pterygia, and previous corneal refractive surgical procedures. Cornea. 2009 Sep 28(8):871-876.

10. Smith RT, Warring GO 4th, Durie DS, Stahl JE, Thomas P. Corneal endothelial cell density after femtosecond thin-flap LASIK and PRK for myopia: a contralateral eye study. J Refract Surg. 2009 Dec 25(12):1098-1102.

11. Patel S, Bourne WM. Corneal endothelial cell loss 9 years after excimer laser refractive surgery. Arch Ophthalmol. 2009 Nov 127(11):1423-1427.

12. Dupps WJ Jr, Qian Y, Meisler DM. Multivariate model of refractive shift in Descemet-stripping automated endothelial keratoplasty. J Cataract Refract Surg. 2008;34(4):578-584.

13. Holz HA, Meyer JJ, Espandar L, et al. Corneal profile analysis after Descemet stripping endothelial keratoplasty and its relationship to postoperative hyperopic shift. J Cataract Refract Surg. 2008 Feb 34(2):211-214.

14. Dapena I, Ham L, Melles GR. Endothelial keratoplasty: DSEK/DSAEK or DMEK-the thinner the better? Curr Opin Ophthalmol. 2009 Jul 20(4):299-307.

Figure 1: Post refractive donor procurement and utilization at Utah Lions Eye Bank 2009-2012

Table 1: Donor Tissue Utilization, Utah Lions Eye Bank, 2009-2012

PKP, penetrating keratoplasty; *ALK*, anterior lamellar keratoplasty; *DSAEK*, Descemet's stripping automated endothelial keratoplasty

Figure 2: Post refractive tissue utilization for endothelial transplant compared to tissue utilization from donors without prior refractive surgery, Utah Lions Eye Bank 2009-2012