Safety and Usability of Corneas Post Vitreous Draw—A Retrospective Study

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ABSTRACT

Purpose: To describe tissue quality and suitability for transplantation of donor corneas recovered following a vitreous draw performed by a coroner or medical examiner, as compared to a control group.

Methods: A retrospective review of donor records was performed for 41 donors (72 donor eyes) who had a vitreous draw performed prior to corneal recovery. Results were compared to a control group of 90 donors (176 eyes) who died of similar causes but did not have a vitreous draw performed. The primary outcome measures are between-group comparisons of endothelial cell density and tissue quality measures for the epithelium, stroma, Descemet's membrane, and endothelium, as well as reportable adverse events.

Results: There were no statistically significant differences in mean endothelial cell density (2999 ± 926 cells/mm² in the study group vs. 2953 ± 980 cells/mm² in the control group) or in quality measures of the epithelium, stroma, or Descemet's membrane. The number and degree of endothelial stress lines were statistically significantly greater in donor corneas in which vitreous draw were performed prior to recovery of corneas. From the study group 72 of the 82 post-vitreous-draw corneas were used by surgeons, with no cases of graft rejection, infection, or other adverse issues.

Conclusions: The data suggest that prior vitreous draw performed by a medical examiner or coroner using a sterile needle has a negligible or non-measurable effect on post-recovery corneal tissue safety, efficacy and transplantation success. Further study is required to assess the degree of endothelial cell loss in post-vitreous-draw donor corneas following transplantation.

Toxicology evaluations and autopsies are often conducted by forensic medical professionals (i.e., medical examiners and coroners) when the donors cause of death is suspicious, when death occurs outside of a hospital setting or doctor's care, or when a death occurs within 24 hours of hospital admission. In many of these cases, the decedent is a potential organ/tissue/eye donor. Organ and tissue organizations, including eye banks, may therefore be involved in recovering tissue from a donor in the custody of the medical examiner or coroner.

As part of their routine protocols in investigating suspicious deaths, forensic medical professionals often obtain a sample of vitreous humor for post-mortem toxicology analysis. Because vitreous humor is relatively isolated from circulated blood and other body fluids that are affected by postmortem chemical changes, it is considered to be of significant forensic value.

The medical examiner or coroner performing a vitreous humor draw generally uses a sterile, fine-gauge needle with a 5 to 10 cc syringe. The needle puncture is usually made through the side of the sclera (Fig 1) to reach the center of the globe behind the lens and in front of the retina. Typically, 2 to 3 cc of fluid are extracted from one or both eyes. Occasionally, the vitreous may be drawn through the cornea instead of the sclera, in these cases the eye bank will typically defer the donor or discard the tissue.

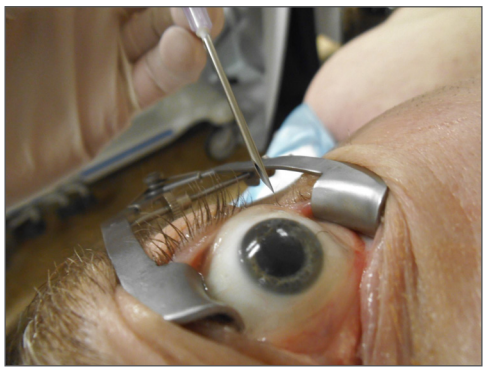

Figure 1 *Forensic medical professionals will often draw vitreous fluid as part of the post-mortem exam.*

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There is no consistent policy among eye banks regarding the use of donor tissue following a vitreous draw. Deflation of the globe during the vitreous draw procedure can make tissue recovery more challenging, and there is some concern that the introduction of a needle into the eye to perform a vitreous draw could increase the bioburden on the tissue, thereby increasing the risk of infection for the graft recipient, or alter the tissue in some other way to increase the risk of graft failure.

To assess these risks, we retrospectively reviewed records for donor and corneal tissue cases in which the donor eye(s) had been subjected to a vitreous draw pre-corneal recovery. Reportable adverse events and tissue quality were compared to those of a similar set of donors who did not undergo vitreous draw prior to corneal recovery.

MATERIALS AND METHODS

Chart reviews were conducted on all post-vitreous-draw corneas accepted and processed as eligible for transplant by the eye bank during a 3-year period, a total of 72 corneas from 41 donors were evaluated.

For comparison purposes, a control group of eyes from similar type donors who did not undergo vitreous draw prior to corneal recovery was established. It was determined that this group should encompass approximately twice as many eyes as the study group, so records were reviewed for 176 transplant-eligible corneas from 90 donors with causes of death like those of the study group.

All the donor eyes in both groups were recovered, processed and evaluated in accordance with acceptable eye bank standards, including specific standards for eyes that have undergone vitreous draw. For example, in all vitreous draw cases, the medical examiner or coroner was contacted to confirm the location of the puncture site and if a sterile needle was used for the vitreous draw. If sterile procedures were not followed or the vitreous was drawn through the cornea, that tissue was not recovered or was discarded and not eligible for transplant.

Vital statistical information including race, gender, age, and cause of death was recorded for all donors. Any facial trauma reported by the forensic medical professional was recorded, as well as the need for a sepsis consult, and any other general observations made by the recovery technician. For the vitreous draw study group, the corneal surgeon's feedback regarding any adverse reactions or positive rim changes was also recorded.

SightLife standard tissue processing quality parameters were recorded for all corneas. These quality parameters include average endothelial cell density and slit lamp evaluation of the epithelium, stroma, Descemet's membrane, and endothelium. Cell counts are routinely performed in a randomized fashion, with no special attention given to any one section of the endothelium during specular evaluation. During slit lamp evaluations of tissue quality, SightLife documentation practices require technicians to grade exactly what they see using standardized language (e.g., "mild central epithelial exposure" or "clear and compact stroma") rather than grading the tissue qualitatively as, for example, "poor,", "fair," or "good". Quality analyses of tissues in both groups were performed prior to any laser or manual trephination.

RESULTS

The mean age in the vitreous draw study group was 38.5 years. The donors were predominantly male and Caucasian (87.8%). Causes of death included 22 motor vehicle accidents (MVA, 54%); 8 cases involving a drug overdose, hanging, or drowning (19%); and 10 cases (27%) in which the donors died of myocardial infarction (MI), arteriosclerotic cardiovascular disease (ASCVD) or other medical causes.

The control group was selected by cause of death, with a distribution very much like that of the study group (Fig 2). Table 1 also shows that the two groups were well-matched, although there was a higher proportion of males in the study group than in the control group.

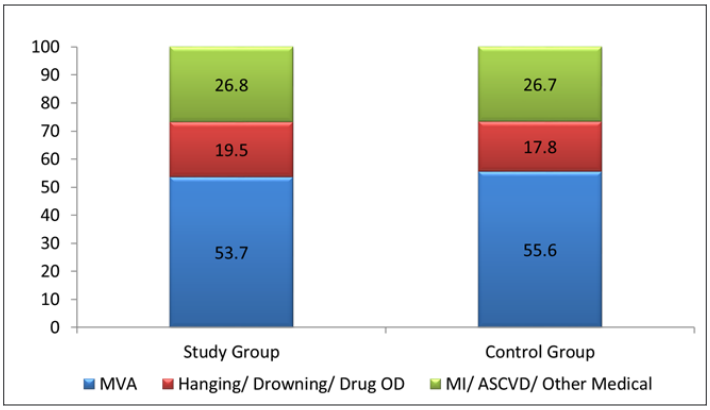

Figure 2 *Donors were categorized into three groups, according to cause of death: Motor vehicle accident (MVA); hanging, drowning, or drug overdose (OD); or myocardial infarction (MI), arteriosclerotic cardiovascular disease (ASCVD), or other medical causes. The distribution of the two groups was very similar.*

In 26 of 41 donors (63.4%) in the vitreous draw group and 51 of 90 donors (56.7%) in the control group, some facial trauma was noted, ranging from bumps and bruises to lacer-

Table 1

Donor Demographics	Study Group (n=41)	Control Group (n=90)
Mean age in years (range)	38.5 (12-70)	38.3 (2-74)
Donors ≤40 years (%)	53.3	51.1
Gender (% Male)	73.2	62.2
Race (% Caucasian)	87.8	88.9
Presence of facial trauma	63.4	56.7
Sepsis consult sought	2.4	3.3

ations, abrasions, and fractures. Facial trauma was most likely in the MVA cases in both groups. A sepsis consult was sought in very few cases in either group.

TISSUE QUALITY

There was no significant difference between the vitreous draw and control groups in average endothelial cell density (ECD). ECD was 2999 ± 926 cells/mm² for the vitreous draw study group versus 2953 ± 980 cells/mm² for the control group.

A slight majority in both groups had mild to moderate central epithelial exposure. There were no clinically significant differences in epithelial quality parameters (Fig 3).

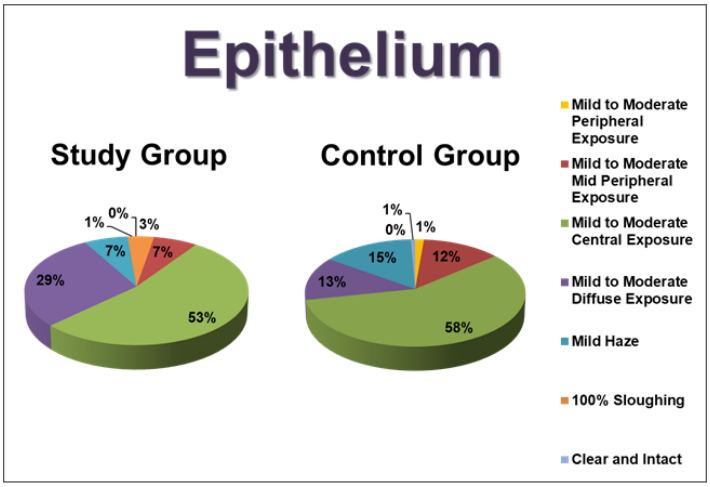

Figure 3 *The distribution of the types of epithelial exposure is similar between the vitreous draw study group and the control group.*

A majority of the eyes in both groups had clear and compact stroma (Fig 4). The vitreous draw group was more likely to have mild to moderate central/anterior edema, but the percentage of cases (6% vs. 1% of controls) was still low. Differences in arcus between the study and control groups were minimal and not clinically significant.

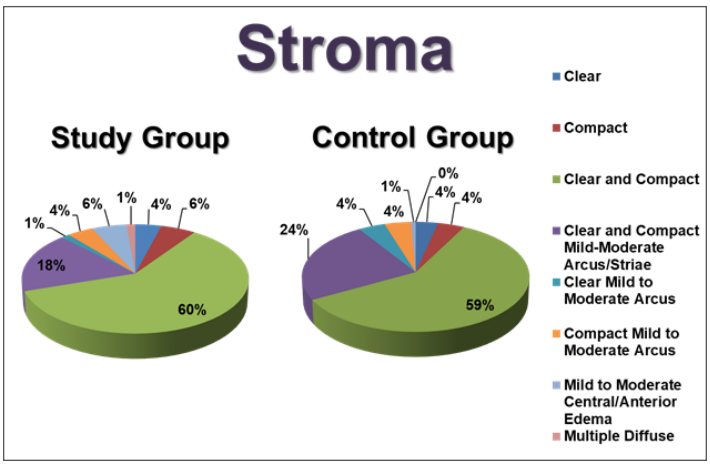

Figure 4 *The distribution of stromal quality in the vitreous draw group is not significantly different from the control group.*

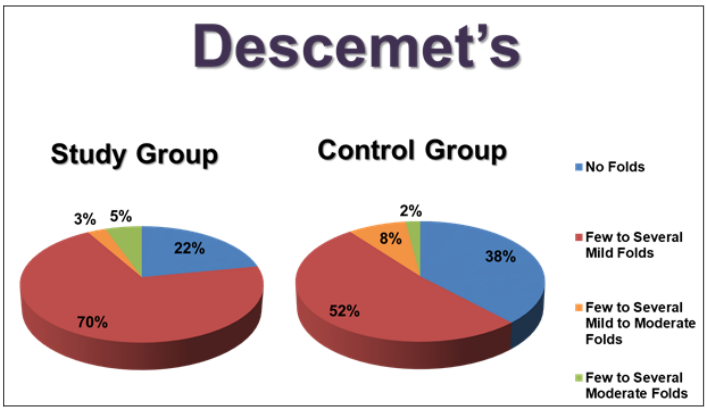

Figure 5 *Although the vitreous draw study group was more likely to have Descemet's folds, the folds were generally noted as few to several, rather than moderate or severe.*

The vitreous draw study group was more likely to have folds in Descemet's membrane (Fig. 5). While the analysis by cause of death is not shown here, eyes from the control group donors who died from hanging, drowning or drug overdose were also more likely to have Descemet's folds than eyes from donors who died of other causes.

Endothelial stress lines were more likely, numerous, and more central in the study group than in the control group (Fig 6). However, in the both the study and control group none of the eyes had severe endothelial stress lines. Excessive stress lines will often reduce the endothelial cell count below the threshold for transplantation. Otherwise, corneas with more stress lines are typically identified as such; the decision to use the tissue based on that information is the surgeon's.

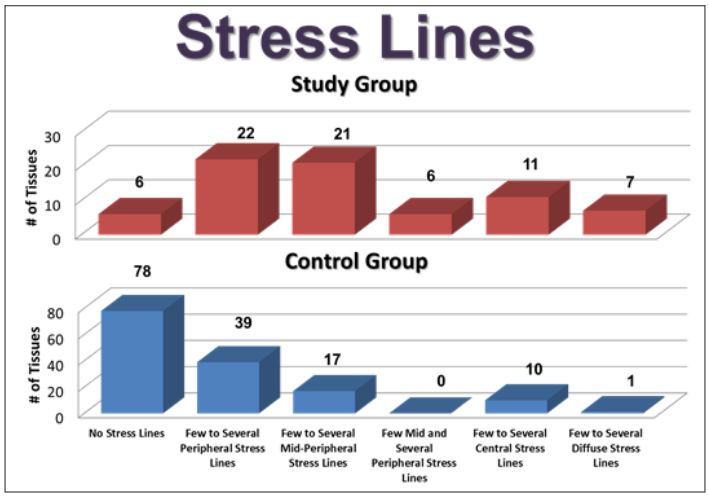

Figure 5 *Graphical representation of the distribution of endothelial stress lines in each group. Most of the control group have no or few stress lines, compared to more frequent and more numerous stress lines in the vitreous draw study group.*

TISSUE USAGE

Three-quarters of the post-vitreous-draw corneas (56 or 68%) were used for penetrating keratoplasty procedures; 10 (12%) were used for endothelial keratoplasty; and three for anterior lamellar keratoplasty. Three corneas from the vitreous draw group were deemed not suitable for transplant due to stress lines but were still used for patch grafts. The remaining 10 were found not suitable for transplant for other reasons. There were no graft failures, infections, or other problems reported by the corneal transplant surgeon in the control or the study group at the time of data collection, nor have any problems been reported to date with any of the corneas transplanted post vitreous draw.

DISCUSSION

We are not aware of any other published studies examining the viability of corneal tissue post vitreous draw or the risks of transplanting such tissue. Analyses of risk factors for donor cornea contamination have not previously highlighted any specific increased risk from autopsy or traumatic death.[1-3] In fact, the opposite may be true. Autopsies (with or without vitreous draw) are typically ordered in cases in which the cause of death is sudden, traumatic, and/or suspicious. And because those who suffer a traumatic death are often younger decedents with healthy corneas, as seen in this study, their eyes may in fact be among the best suited for transplantation.[4-6] There is one report of higher rates of endothelial cell death during organ culture of corneas recovered after traumatic death, but the authors found no increased risk of tissue quality problems if the tissue survived the period of culture.[6]

In general, the donors in this study were younger-than-average donors with relatively high cell counts. In many cases, particularly those with motor vehicle accident as the cause of death, recovery took place very soon after death, which also increases the viability of the tissue.

This study suggests that a vitreous draw performed prior to corneal recovery has negligible effects on the measurable quality of a transplantable cornea. Average endothelial cell density, a critical standard for evaluating corneal suitability for transplantation, was seemingly unaffected by vitreous draw. Slit lamp observations for the epithelium, stroma and Descemet's membrane were comparable between the vitreous draw and control groups.

Endothelial stress lines are an indication of more trauma to the tissue. Physical folding of corneal tissue and/or localized edema stresses the endothelial cells in the immediate vicinity, resulting in cell death and a visible stress line. It was not surprising that we observed an increase in endothelial stress lines in the vitreous draw group given that the globes would have been deflated during the vitreous draw. The central question was whether that additional trauma increased the risk of using that tissue. In all seventy-two of the eighty-two corneas from the study group were used by surgeons for vision-restoring transplant procedures.

Based on the data in this retrospective review, we have no indication of a negative effect of prior vitreous draw on transplantation outcomes provided those corneas are otherwise deemed suitable for transplant. Further studies to evaluate the degree of endothelial cell loss in donor corneas post vitreous draw following corneal transplantation may be warranted.

Post vitreous draw there may be a greater likelihood of corneal tissue being deemed not suitable for transplant but if it is suitable for transplant, there is no indication that there is greater risk for the recipient of graft failure or corneal infection. While it may be preferable to have corneal tissue with no stress lines, this study shows that corneas from the type of young donor likely to undergo an autopsy or forensic investigation can safely be used for corneal transplantation even if a vitreous draw has been performed by the coroner or medical examiner.

REFERENCES

1. Linke SJ, Fricke OH, Eddy MT, et al. Risk factors for donor cornea contamination: retrospective analysis of 4546 procured corneas in a single eye bank. *Cornea* 2013;32(2):141-8.
2. Armitage WJ, Jones MN, Zambrano I, et al; NHSBT Ocular Tissue Advisory Group and Contributing Ophthalmologists OTAG Audit Study 12. The suitability of corneas stored by organ culture for penetrating keratoplasty and influence of donor and recipient factors on 5-year graft survival. Invest *Ophthalmol Vis Sci* 2014 10;55(2):784-91.
3. Hassan SS, Wilhelmus KR, Dahl P, et al; Medical Review Subcommittee of the Eye Bank Association of America. Infectious disease risk factors of corneal graft donors. *Arch Ophthalmol* 2008;126(2):235-9.
4. Hirai FE, Adán CB, Sato EH. [Factors associated with quality of donated corneas in the Hospital São Paulo Eye Bank]. [Article in Portuguese] *Arq Bras Oftalmol* 2009;72(1):57-61.
5. Krohn J, Høvding G. The influence of donor age and cause of death on corneal endothelial cell density. *Acta Ophthalmol Scand* 2005;83(6):746-50.
6. Sobottka Ventura AC, Rodokanak-von Schrenk A, Hollstein K, et al. Endothelial cell death in organ-cultured donor corneae: the influence of traumatic versus nontraumatic cause of death. *Graefes Arch Clin Exp Ophthalmol*. 1997;235(4):230-3.