Early changes in host and donor lenticule thickness after Descemet stripping endothelial keratoplasty

Bandana Yien, Arnav Ghosh, Smruti R Priyadarshini, Srikant K Sahu, Debananda Padhy, Mohammad Hasnat Ali, Sujata Das

Purpose: To analyze the early changes in host and donor lenticule thickness after Descemet Stripping Endothelial Keratoplasty (DSEK). Methods: DSEK was performed on 32 eyes of 31 patients. Pre- and post-operative slit lamp examination and anterior segment Optical Coherence Tomography (OCT) was done on day-1, day-7, 1 month, and 3 months. Results: There were significant changes in host, lenticule, and total corneal thicknesses between day-1 and day-7, and day-7 and 1 month. There were significant changes in host thickness and total corneal thickness between 1 month and 3 months. Thickness changes were significant between day-1 and day-7, and 1 month and 3 months for thick and thin host, respectively, whereas these changes were observed both for thick and thin host between day-7 and 1 month. Similarly, significant changes were observed between day-7 and 1 month, and day-7 and 1 month in thin lenticule whereas in case of thick lenticule, it was observed till the 3 months follow-up period. There was a significant improvement in visual acuity till the 3 months follow-up period. No significant correlation was observed between visual acuity and host and lenticule thickness. Conclusion: The thicknesses of host and lenticule decrease continuously. Lenticule thickness stabilizes before host. Thinner cornea stabilizes earlier compared to thicker cornea.

Key words: DSEK, lenticule, lenticule thickness

Endothelial Keratoplasty (EK) is a widely performed procedure for corneal endothelial dysfunction. Descemet Stripping Endothelial Keratoplasty (DSEK) is the most popular technique because of its excellent outcome and relatively short learning curve compared to alternate EK methods.[1] Visual acuity after DSEK usually improves up to 0.3 logMAR but may even increase further as time passes and corneal remodeling occurs.[1] The stromal deturgescence and recovery of homogenoc thickness after DSEK is related to the postoperative rehabilitation of the affected eye, especially in bullous keratopathy. This can be objectively measured by the central corneal and grafted lenticule thickness.[2] A recent meta-analysis does not show strong association or clinically relevant relationship between the graft thickness and the visual acuity.[3]

Controversy regarding the outcome of visual acuity in eyes with thin grafts versus thick grafts, years after surgery, has been of great interest in many articles.[4,5] Whether corneal thickness plays a role in post-DSAEK (Descemet Stripping Automated Endothelial Keratoplasty) visual performance remains a point of contention to date.

In a study comparing the outcomes of DSAEK with DSEK by Price et al.,[6] it was observed that the cornea was significantly thicker in the microkeratome group. Also, DSEK group was associated with a faster visual recovery compared to DSAEK group.

A study was conducted by Hindman et al.[7] to assess the impact of ocular wave front aberrations, corneal thickness, and corneal light scatter post-DSEK. They found that although ocular High Order Aberrations (HOA) and scatter were both elevated, improvements in visual performance occurring over the first year post-DSAEK were associated with decreasing light scatter as no significant changes were seen over time in the ocular HOA. The corneal light scatter decreased over a period of 1 year, despite a stable corneal thickness.[7]

Pogorelov et al.[1] used organ-cultured corneal donor tissue for DSAEK. With a 6 month follow-up, they showed that the thickness of the grafted corneal lenticule decreased continuously during the follow-up and correlated well with the postoperative best corrected visual acuity (BCVA).[1]

In the present study, donor corneas were stored in McCarey-Kaufman (MK) medium and lenticules were prepared manually. Postoperatively, the changes in lenticule thickness were evaluated using the Visante Anterior Segment

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

Cite this article as: Yien B, Ghosh A, Priyadarshini SR, Sahu SK, Padhy D, Ali MH, et al. Early changes in host and donor lenticule thickness after Descemet stripping endothelial keratoplasty. Indian J Ophthalmol 2022;70:529-34.
OCT (AS-OCT) (Carl Zeiss Meditec, Inc.) for a period of 3 months.

**Methods**

**Study design**

A prospective, longitudinal, descriptive study was conducted at a tertiary eye care institute in eastern India, from March 2015 to October 2019, including all patients who underwent DSEK for various causes of endothelial dysfunction. It was designed to evaluate the natural course of the DSEK lenticule and the corneal thickness over the first 3 months after the surgery. Study was approved by the Institutional Review Board/Ethics Committee under protocol number (2015-38-IM-7), and the study follows the guidelines of the Declaration of Helsinki.

**Study population**

Patients of all age groups who underwent DSEK at the Centre and came for a follow-up period of 3 months and had undergone AS-OCT on day-1, day-7, 1 month, and 3 months were included in the study. Patients who had intra-operative complications and primary graft failure or graft infiltrates were excluded from the study.

**DSEK surgery**

All surgeries were done under peribulbar anesthesia. Lenticules were prepared manually using the Barron Artificial Anterior Chamber (Katena, Denville, NJ). Recipient’s corneal epithelium was removed in all patients. Sheets’ glide was used to insert the lenticule. After proper centration of lenticule (using balanced salt solution, BSS), air bubble (80–90% of graft size) was injected below the lenticule. Main tunnel and side ports were sutured using 10-0 nylon.

**Imaging instrument**

The Visante AS-OCT was used in this study. It uses a wavelength of 1310 nm. The AS-OCT obtains cross-sections of the cornea with 18-µm axial resolution (optical) and 60-µm transverse resolution, at a maximum scan width of 16 mm and a scan depth of 6 mm. Data output included central host and donor lenticule thickness.

**Data collection**

Pre- and post-operative slit lamp examination and AS-OCT was done on day-1, day-7, 1 month, and 3 months. The AS-OCT measurements were performed manually by a single observer, with the subject in sitting position, and the scanning line positioned on the corneal vertex in the 180-degree axis. Measurements of the central corneal thickness (CCT) were taken within 1 mm of the central zone. The central lenticular thickness was measured using the in-built caliper tool of the OCT machine. It is the axial distance between the graft–host junction to the posterior corneal endothelium. Host corneal thickness is the axial distance between the graft–host junction and the anterior boundary of the cornea.

**Statistical analysis**

Statistical analyses were performed using MedCalc (v. 19.1). Wilcoxon test was carried out using the non-parametric paired observations. Spearman’s rank correlation coefficient (ρ or rho) was carried out to analyze the degree of association between postoperative vision and lenticule and host thickness. A P value of <0.05 was considered statistically significant. Based on the median thickness value of host, lenticule, and total central corneal thickness on day-1 (i.e., 575, 225, 855 microns, respectively), it was divided into two groups.

**Results**

Thirty-two eyes (OD:OS = 19:13) of 31 patients (M:F = 16:15) were included in the study. Most common indication of DSEK was pseudophakic/aphakic bullous keratopathy (n = 21). Other indications were failed graft (n = 3), Fuchs’ endothelial dystrophy (n = 3), iridocorneal endothelial syndrome (n = 1), corneal decompensation (n = 2), and congenital hereditary endothelial dystrophy (n = 2). The mean age group was 60 ± 20 (range: 7–80) years. All donor tissues were of good quality and stored in MK medium. Grading was done under the slit lamp. Mean donor cell count and thickness of donor cornea at the time of surgery was 3143 ± 342 (95% CI: 3025-3262) cells/mm² and 519 ± 18 (95% CI: 512-525) microns, respectively. No intra-operative complication occurred in any patient.

**Figure 1:** OCT imaging of the cornea at (a) day-1, (b) day-7, (c) 1 month, (d) 3 months after DSEK
Rebubbling was required in nine eyes on postoperative day-1 for partial detachment of DSEK lenticule. No graft rejection was observed in any patient during the follow-up period.

AS-OCT was used to measure the host cornea and DSEK lenticule thickness [Fig. 1]. The median thicknesses of central cornea (both host and lenticule thickness together) were 855, 765, 650, and 620 microns on day-1, day-7, 1 month, and 3 months, respectively. There is a significant difference in total central corneal thickness in each visit compared to the previous visit till 3 months [Table 1]. While there was no significant difference after 1 month in cases of thin cornea (≤855 micron), it continued till 3 months in cases of thick cornea (>855 micron) [Table 2]. The median central host thickness was 575, 530, 495, and 480 microns on day-1, day-7, 1 month, and 3 months, respectively. The median central lenticule thickness was 225, 200, 150, and 150 microns on day-1, day-7, 1 month, and 3 months, respectively [Table 1]. There were significant changes in host thickness between day-1 and day-7 (P = 0.0002), and day-7 and 1 month (P < 0.0001). Similarly, there were significant changes in lenticule thickness between day-1 and day-7 (P = 0.0001), and day-7 and 1 month (P = 0.0001). While there was significant change in host thickness (P = 0.0271), there was no significant change in lenticule thickness (P = 0.1007) between 1 month and 3 months [Fig. 2].

Changes in lenticule and host thickness in two groups (i.e., thick and thin) with time were compared. Changes in lenticule and host thickness in two groups (i.e., thick and thin) with time were compared. While significant changes were observed between day-1 and day-7 (P = 0.0006), and day-7 and 1 month (P = 0.0001) in case of thick host (>575 micron); in case of thin host, it was between day-7 and 1 month (P = 0.0063), and 1 month and 3 months (P = 0.0353) [Table 3]. Similarly, significant changes were observed between day-7 and 1 month (P = 0.0092), and day-7 and 1 month (P = 0.0245) in thin lenticule (≤225 micron) whereas in case of thick lenticule, it was observed till the 3 month follow-up period, that is, between
day-1 and day-7 (P = 0.0006), day-7 and 1 month (P = 0.0006), and 1 month and 3 months (P = 0.0425) [Fig. 3].

Preoperative best corrected visual acuity (BCVA) ranges from 0.30 to 3.00 logMAR (Median, Interquartile Range: 2.00, 1.60-3.00). There was significant improvement in visual acuity between day-1 and day-7 (P = 0.0039), day-7 and 1 month (P = 0.0001), and 1 month and 3 months (P = 0.0001) [Table 4]. No significant correlation was observed for host and lenticule thickness with visual acuity.

Discussion

DSEK is one of the most performed EK because of the advantages of early visual rehabilitation, shorter and less frequent follow-up, less postoperative discomfort, and less chances of postoperative astigmatism. Recent advances in the technique have not only made the surgical steps simpler but also led to early visual recovery. Evolving from the original Melles technique (Posterior Lamellar Keratoplasty, PLK) to the now commonly performed DSEK, this surgical procedure is now a very easily performed common surgical procedure in corneas with poor endothelium.

OCT is a high-resolution cross-sectional imaging technique originally designed for retinal imaging. Later, it was modified with longer wavelength (1310 nm) to allow viewing of anterior segment structures in detail. Visante OCT (Carl Zeiss Meditec, Inc) has many scanning protocols and can capture good horizontal

Table 2: Postoperative Changes in Thick and Thin Cornea (in micron)

| Postoperative Days/Months | Thin Cornea (≤ 855 micron) | Thick Cornea (>855 micron) |
|---------------------------|----------------------------|---------------------------|
| Day-1                     | [A]                        | [E]                       |
| [B]                       | [F]                        |                           |
| [C]                       | [G]                        | [H]                       |
| 1 month                   | [D]                        |                           |
| 3 months                  | [D]                        |                           |

Table 3: Postoperative Changes with Thin (≤ 575 micron) and Thick (> 575 micron) Host, and Thin (≤ 225 micron) and Thick (225 micron) Lenticule

| Host Thickness | Postoperative Days/Months |
|----------------|---------------------------|
| Day-1          | [A]                       |
| Day-7          | [B]                       |
| 1 month        | [C]                       |
| 3 months       | [D]                       |

| Lenticule Thickness | Postoperative Days/Months |
|---------------------|---------------------------|
| ≤ 225 micron        | [E]                       |
| > 225 micron        | [F]                       |

*Cornea Thickness: Central Host Thickness+Central Lenticule Thickness

Statistical Test

Two-tailed Probability

Wilcoxon Test (Paired Samples)
Table 4: Pre- and Post-Operative Best Corrected Visual Acuity (in logMAR)

| Preop Day | Postoperative Days/Months |
|-----------|---------------------------|
| [A]       | [B] | [C] | [D] | [E] |
| Sample Size | n=32 | n=32 | n=32 | n=32 | n=32 |
| Median     | 2.0 | 2.0 | 1.6 | 0.8 | 0.7 |
| Data Range | 0.3-3.0 | 0.8-3.0 | 0.6-3.0 | 0.3-3.0 | 0.1-3.0 |
| 95% CI for the Median | 1.6-3.0 | 2.0-3.0 | 1.1-2.0 | 0.7-0.9 | 0.4-0.8 |
| Interquartile Range | 1.6-3.0 | 1.6-3.0 | 1.0-2.5 | 0.5-1.1 | 0.4-1.0 |
| Statistical Test | --- | Wilcoxon Test (Paired Samples) | | | |
| Two-tailed Probability | P=0.1727 | P=0.0039 | P<0.0001 | P=0.0001 | P=0.0001 |

[A] vs [B] | [B] vs [C] | [C] vs [D] | [D] vs [E] |

Figure 3: Postoperative changes with (a) thin (≤575 micron) and thick (>575 micron) host, and (b) thin (≤225 micron) and thick (>225 micron) lenticule

and vertical centration of the image within the frame. In our study, we analyzed quantitatively the central donor lenticule thickness and central host thickness in subsequent follow-ups.

In our study, MK media at 2–8 degree Celsius was used as the storage media for all the patients. Pogorelov et al. [1] in their study had observed that the donor storage media might have influenced the outcome of DSEK. They used organ-culture media for preservation of donor tissue. There was significant improvement in BCVA at 6 months postoperatively (P < 0.0001). The central corneal thickness showed alterations that were evident in the first 8 weeks and later remained stable. [1] There was no correlation between BCVA and peripheral lenticule thickness. Also, the authors did not observe any significant correlation between BCVA and the duration of the organ-culture medium. In contrast, in our series, thickness of central cornea showed significant difference till the 3 month follow-up period. We have analyzed host and lenticule and total corneal thicknesses separately, as well as in two groups according to their thickness.

In our study, significant reduction in thickness was noticed between day-1 and day-7, and day-7 and 1 month for lenticule. This steep decline was subsequently stabilized after 1 month. Thus, we observed two phases of deturgescence in this study – the initial phase of decline followed by the later slow phase. This may possibly be explained by two mechanisms: firstly, by natural deturgescence of the donor tissue on removal from the tissue storage medium (i.e., MK medium in our study) and secondly, by reactivation of the endothelial pump after a successful endothelial transplant technique. After the initial phase, the rapidity with which the cornea dehydrates slows down, and thus we get a relatively flat curve. As expected, thicker lenticule took longer time for stabilization compared to thinner lenticule. Reduction of lenticule thickness varies from 12% to 39%. [8] The baseline cornea lenticule thickness is considered as baseline in most of the studies. We have noticed a reduction of 33% at 3 months compared to day-1. Lenticule swells up on the first day. Also, this might be due to increased thickness at the beginning. The percentage of reduction is more (52%) in thicker lenticule compared to thinner lenticule (33%). Pogorelov et al. [1] had noticed decrease in thickness of lenticule from 191 to 100 micron in 6 months.

The corresponding host thickness also shows a decline postoperatively. The initial reduction in host thickness is by
rapid deturgescence (day-7 vs. 1 month, $P < 0.0001$) and then almost stable reduction (1 month vs. 3 months, $P = 0.0271$). This shows that the maximum deturgescence of the host cornea occurs till 1 month following surgery. Although the host thickness decreases continuously even after 1 month, significant change was noticed for thinner host after 1 month. Further, this significant change in thin host (after 1 month) may not be relevant clinically as the absolute difference is only 5 microns. Pogorelov et al.\cite{10} have observed that the central corneal thickness, peripheral corneal thickness, and the grafted corneal lenticule showed significant reduction in thickness over 6 month follow-up period.

We analyzed the central cornea thickness in two groups; the thin cornea group stabilized by 1 month. However, significant difference was noticed between 1 and 3 months in the thick cornea group. Similarly, the thin lenticule group stabilized by 1 month. However, the visual acuity continued to improve irrespective of lenticule and host thickness. While surgeons have no control on the host thickness, the lenticule thickness can be planned as per the surgeon’s convenience. Thin lenticule might be a better option in early stabilization.

Significant difference was noticed in best corrected visual acuity (BCVA) between 1- and 3-month. There was constant decrease in central host corneal as well as central donor lenticule thickness till 1 month follow-up period. No significant correlation was observed between BCVA and central donor lenticule thickness. Koenig et al.\cite{9} concluded that post DSAEK visual acuity of 20/25 or even 20/20 can be achieved.\cite{10} In our study, after 3 months of follow-up, BCVA of 20/60 was achieved in 14 patients. In all 32 eyes of 30 patients, the cornea cleared after 3 months of surgery with improved visual acuity. We did not analyze if the reduction in thickness is interdependent between host and lenticule. As all the tissues were manually prepared, there may be ongoing stromal remodelling even after 3 months. The limitations of our study are retrospective, multiple surgeons, and follow-up of 3 months.

**Conclusion**

The thicknesses of host and lenticule decrease continuously. Lenticule thickness stabilizes before host. Thinner cornea stabilizes earlier compared to thicker cornea.

**Financial support and sponsorship**

Hyderabad Eye Research Foundation, Hyderabad.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Pogorelov P, Cursiefen C, Bachmann BO, Kruse FE. Changes in donor corneal lenticule thickness after Descemet’s stripping automated endothelial keratoplasty (DSAEK) with organ-cultured corneas. Br J Ophthalmol 2009;93:823-9.
2. Kanellopoulos AJ, Asimellis G. Anterior-segment optical coherence tomography investigation of corneal deturgescence and epithelial remodeling after DSAEK. Cornea 2014;33:340-8.
3. Wacker K, Bourne WM, Patel SV. Effect of graft thickness on visual acuity after Descemet stripping endothelial keratoplasty: A systematic review and meta-analysis. Am J Ophthalmol 2016;163:18-28.
4. Neff KD, Biber JM, Holland EJ. Comparison of central corneal graft thickness to visual acuity outcomes in endothelial keratoplasty. Cornea 2011;30:388-91.
5. Ahmed KA, McLaren JW, Baratz KH, Maguire LJ, Kittleson KM, Patel SV. Host and graft thickness after Descemet stripping endothelial keratoplasty for Fuchs endothelial dystrophy. Am J Ophthalmol 2010;150:490-7.
6. Price MO, Price FW Jr. Descemet’s stripping with endothelial keratoplasty: Comparative outcomes with microkeratome-dissected and manually dissected donor tissue. Ophthalmology 2006;113:1936-42.
7. Hindman HB, Huxlin KR, Pantanelli SM, Callan CL, Sabesan R, Ching SS, et al. Post-DSAEK optical changes: A comprehensive prospective analysis on the role of ocular wavefront aberrations, haze, and corneal thickness. Cornea 2013;32:1567-77.
8. Meter A, Kuzman T, Kalauz M, Škergo I, Masneć S, Pavan J. Postoperative thinning of lamellar donor graft after conventional Descemet’s stripping automated endothelial keratoplasty. Acta Clin Croat 2018;57:653-7.
9. Koenig SB, Covert DJ. Early results of small-incision Descemet’s stripping and automated endothelial keratoplasty. Ophthalmology 2007;114:221-6.
10. Koenig SB, Covert DJ, Dupps WJ Jr, Meisler DM. Visual acuity, refractive error, and endothelial cell density six months after Descemet stripping and automated endothelial keratoplasty (DSAEK). Cornea 2007;26:670-4.