Original Article

# Effects of Descemet Stripping Automated Endothelial Keratoplasty on Corneal Densitometry of Cases with Long-Standing Pseudophakic Bullous Keratopathy

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## Abstract

**Purpose:** To quantify the effects of Descemet stripping automated endothelial keratoplasty (DSAEK) on corneal clarity and densitometry of patients with long-standing pseudophakic bullous keratopathy (PBK) complicated with subepithelial fibrosis.

**Methods:** Thirty-four eyes with PBK complicated with corneal edema for more than 6 months and subepithelial fibrosis were enrolled. All subjects underwent complete ophthalmic examination and corneal densitometry module of Pentacam HR, before and 1, 3, and 6 months after DSAEK.

**Results:** Thirteen patients were excluded due to postoperative complications or missed to follow-up visits. Finally, twenty-one patients' data were analyzed. Corneal densitometry measures significantly decreased in all three layers (anterior, central, and posterior) 3 and 6 months after surgery compared to preoperative values; however, the differences did not reach statistical significance in the 1st month. Moreover, densitometry measurements were significantly lower at month 6 compared to month 1, but not at month 3 compared to month 1. Corneal densitometry of the anterior layer was significantly higher than central and posterior layers in 2 mm and 6 mm zones preoperatively and at all postoperative visits. Corneal light backscatter of each three layers was not statistically different between 0–2 mm and 2–6 mm in all pre- and postoperative visits.

**Conclusions:** Corneal densitometry in cases of PBK begins to improve after DSAEK in different layers in a slow and continued trend which takes up to 6 months for an effect to be seen. Interestingly, this improvement is possible even in complicated corneas with long-standing edema. Hence, corneal densitometry can be used as an objective method for quantification of the outcome of DSAEK in complicated cases of PBK.

**Keywords:** Corneal densitometry, Descemet stripping automated endothelial keratoplasty, Pentacam, Pseudophakic bullous keratopathy

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## Introduction

Endothelial keratoplasty has become the choice procedure for the treatment of endothelial decompensation secondary to pathologies such as pseudophakic bullous keratopathy (PBK) and Fuchs' endothelial dystrophy.[1] For the time being, Descemet stripping automated endothelial keratoplasty (DSAEK) is the most widely performed endothelial keratoplasty technique. Although Descemet's membrane endothelial keratoplasty (DMEK) is becoming the preferred option among most corneal surgeons, DSAEK can be considered a better technique in complicated cases.[2-5]

PBK accounts for 15%–37% of keratoplasty procedures.[6-8] In Iran, bullous keratopathy is the second leading cause of corneal transplantation (18%), following keratoconus.[9] It seems that PBK patients have worse outcomes than a similarly aged group of patients with primary endothelial disease (e.g., Fuchs' dystrophy and related diseases). It may be related to a higher

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incidence of postoperative complications (rejection and graft failure) and accompanied pathologies adversely affecting vision.[10-12] On the other hand, a slow healing process and many uncertain factors, like preexisting systemic or ocular comorbidities, can lead to prolonged rehabilitation time after keratoplasty. Inflammation caused by epithelial bullae and erosions are consequences of long-term edema, which may lead to corneal vascularization and poor outcomes.[10] Thus, a shorter duration of corneal edema may be associated with better visual outcomes.

It is so important to know the rehabilitation course after keratoplasty which can improve our patient selection, patient education, and making the expectations more realistic. Most of the previous studies are focused on graft survival. Although the importance of this issue is clear, comprehensively considering of all aspects is necessary. Postoperative visual acuity depends on various factors such as maculopathies and media opacities like capsular bag opacification. Hence, using an objective method for pure evaluation of corneal rehabilitation can be helpful. Corneal thickness measurement is another way of evaluating corneal rehabilitation and decrease of corneal edema; however, its limitation in patients who have undergone DSAEK is that the lenticule thickness can be a confounding factor.

In addition to vision and corneal thickness, measuring graft transparency can be spotted for the evaluation of keratoplasty success. Through the innovations and promotion of imaging modalities, corneal densitometry (backscattered light) can be used for assessing this parameter. The Pentacam HR (OCULUS, Wetzlar, Germany) has been equipped with the densitometric analysis software system which measures backscattered light intensity from different regions of the cornea. Previously, this modality has been applied on monitoring corneal transparency after collagen cross-linking, corneal graft surgery, refractive surgery, infectious keratitis, corneal dystrophies, and different stages of keratoconus.[13-24]

The aim of this study was to compare the corneal densitometry using the Pentacam Scheimpflug corneal tomography in patients with PBK, before and after DSAEK. It is of note that, unlike previous studies, we enrolled complicated cases with prolonged edema and subepithelial fibrosis.

## Methods

This prospective study was conducted from January 2017 to December 2018 at Farabi Eye Hospital, Tehran, Iran. This research was undertaken in accordance with the Declaration of Helsinki and was reviewed and approved by the Ethical Review Board of Farabi Eye Hospital (IR.TUMS.FARABIH.REC.1401.033) and conforms to principles and applicable guidelines for the protection of human subjects in biomedical research. The consent form was obtained from the patients included in the study.

Patients with prolonged corneal edema (more than 6 months) due to PBK with significant haze (in which the iris details could hardly be examined) were consecutively included in this study. DSAEK was performed for all patients. All of our graft lenticules were thin grafts in the thickness range of 80–100 µm. Exclusion criteria were postoperative complications, including graft detachment, failure, and rejection, need for another surgery (glaucoma surgery and rebubbling), corneal infection, or intraocular inflammation. However, visual impairment due to maculopathy, optic neuropathy, or posterior capsular opacity, corneal vascularization, and fibrosis were not exclusion criteria.

All subjects underwent a comprehensive ophthalmic examination, including the best-corrected visual acuity, intraocular pressure measurement, slit-lamp biomicroscopy, fundus examination if feasible, and Pentacam HR (OCULUS GmbH, Germany), for measurement of central corneal thickness and densitometry preoperatively, and at 1, 3, and 6 months after operation. Only patients with complete pre- and postoperative data were included. The main outcome of this study was measuring corneal densitometry change after DSAEK.

Corneal densitometry was measured with densitometry software of the Pentacam HR (OCULUS GmbH, Germany) over a 12 mm diameter of the cornea. This area is further divided into four concentric zones centering on the corneal apex: central 2 mm, 2–6 mm, 6–10 mm, and 10–12 mm. The densitometry values were also measured in different corneal depths, which consisted of the anterior layer: superficial 120 µm of the cornea, posterior layer: 60 µm of the innermost cornea, central layer: volume between these two layers without fixed thickness, and total layer. Corneal densitometry values are expressed as the pixel luminance per unit volume in the Scheimpflug image and are expressed in grayscale units (GSUs). The measurements range from 0 (maximum transparency) to 100 (completely opaque cornea) according to the degree of backscattered light from the cornea.[24,25] The densitometric values in the anterior, central, posterior, and total layers in 2 and 6 mm diameter annuli were analyzed. Since the donor rim was located at about 8 mm diameter and peripheral corneal changes, including vascularization and opacities may affect the measurements, we did not analyze radii of 6–10 mm and 10–12 mm. All examinations were performed in the same room under low light conditions by an experienced technician. Figure 1 shows the Pentacam densitometry printout of a patient. Densitometric values have been shown in different annuli and three layers.

### Statistical analysis

Data were presented as mean, standard deviation, median and range, frequency, and percentage. To compare the densitometries in different times, we used a linear mixed model. Other linear mixed models were used to compare the 2 and 6 mm radii within different layers and different layers within the studied radii. To consider the multiple comparisons, we used the Sidak method. All statistical methods were performed by SPSS software (IBM Corp, Released 2017, IBM SPSS

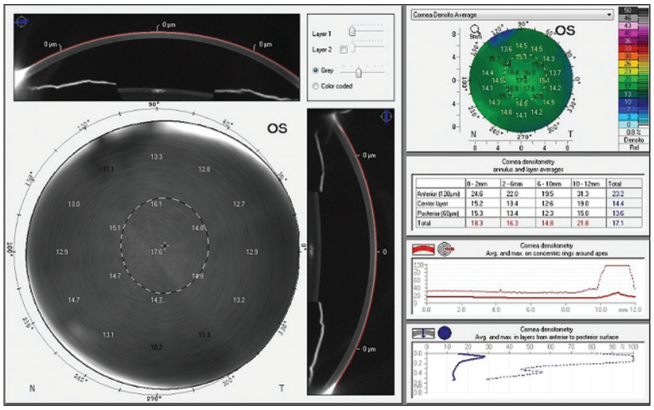

**Figure 1:** Pentacam densitometry printout of a patient. Densitometric values have been shown in different annuli and three layers

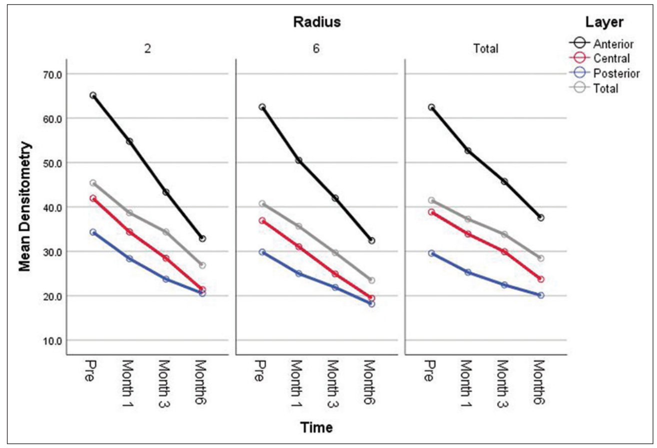


**Figure 2:** The rate of change in densitometry values from preoperation time (pre) to month 1, month 3, and month 6 postoperation at the anterior, central, posterior, and total layers

Statistics for Windows, version 25.0. Armonk, NY, USA: IBM Corp.). $P < 0.05$ was considered statistically significant.

## Results

Thirty-four eyes of 34 patients were included in this prospective study. Nine patients were excluded due to postoperative complications, including intraocular pressure rise, graft detachment, and graft failure. Four patients did not complete follow-up visits. Finally, a total of 21 patients were available for analysis (age: 64.0 ± 8.2 years; 13 female, 8 male).

The mean corneal densitometry of the total cornea decreased from 41.5 GSUs at preoperation time to 37.3, 33.8 GSU and 28.4 GSU at 1, 3, and 6 months after surgery, respectively. Corneal densitometry measures significantly decreased in all three layers (anterior, central, and posterior) 3 and 6 months after surgery compared to preoperative values, although the differences did not reach statistical significance in the 1st month. Moreover, densitometry measurements were significantly lower at month 6 compared to month 1, but not at month 3 compared to month 1 [Table 1]. Figure 2 shows the rate of change in densitometry. The rate of change in the central layer is more pronounced than in the anterior and posterior layers, which may be due to that the interface lies in the central layer.

Corneal light backscatter of the anterior layer was significantly higher than central and posterior layers in 2-mm and 6-mm zones, preoperatively and at all postoperative visits. However, the difference between the central and the posterior layers was not significant except for the total corneal thickness [Table 2]. Corneal light backscatter of each three layers (anterior, central, and posterior) was not statistically different between 0–2 mm and 2–6 mm in all pre- and postoperative visits.

In our study, the mean of preoperative best-corrected visual acuity was counting fingers at 1 m (1.8 logMAR), which significantly improved to a mean of 20/100 (0.7 logMAR) at the 6th-month follow-up visit ($P < 0.01$); however, it was not correlated with the improvement in densitometry ($P > 0.05$).

Central corneal thickness showed a significant decrease after surgery up to 3 months, from 682 ± 86 µm at preoperation time to 558 ± 80 µm in the 3rd month ($P < 0.01$); however, the decrease was not significant after 3 months. Furthermore, no correlation was observed between the densitometry and pachymetric values.

## Discussion

Endothelial keratoplasty provides the option of selective substitution of the Descemet's membrane and the corneal endothelium. This technique has remarkable advantages over penetrating keratoplasty such as more rapid visual recovery and healing, better outcomes, less postoperative astigmatism, and lower chance of graft rejection. It is the preferred surgical procedure for corneal endothelial dysfunction secondary to Fuchs' endothelial dystrophy or PBK.[26] DSAEK and DMEK are the two widely accepted techniques of endothelial keratoplasty. In DMEK, only the endothelium and Descemet's membrane are transferred; however, in DSAEK, the graft also contains a thin layer of the donor's posterior stroma.[27]

Traditionally, visual acuity is an important parameter for evaluating postoperative outcomes. However, maculopathies or optic neuropathies may act as confounding factors. Thus, focusing on corneal-specific factors may be more rational. One of these factors is corneal densitometry which can provide a quantitative tool for evaluating of optical quality of the graft and corneal transparency in the different corneal layers independent to possible preexisted pathologies of the other parts of the eye. It is noticeable that PBK usually affects elderly patients who are more prone to accompanied ocular pathologies such as age-related macular degeneration, ischemic retinopathy, and optic neuropathy.[28] Furthermore, many of these patients have a history of previous complicated cataract surgery which increases some media and posterior segment complications such as capsular opacification and macular edema potentially affecting visual acuity. Nevertheless,

**Table 1: Change in corneal densitometry (mean±standard deviation) in different layers and different radiuses**

| Layer | Radius (mm) | Time | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Preoperative, mean±SD | Month 1 | | Month 3 | | | Month 6 | | | |
| | | | Mean±SD | *P*1 | Mean±SD | *P*1 | *P*2 | Mean±SD | *P*1 | *P*2 | *P*3 |
| Anterior | 0–2 | 65.1±11.1 | 54.8±11.8 | 0.09 | 43.3±8.9 | 0.00 | 0.03 | 32.9±8.7 | 0.00 | 0.00 | 0.01 |
| | 2–6 | 62.5±12.1 | 50.5±11.8 | 0.04 | 42±12.7 | 0.00 | 0.36 | 32.4±10.2 | 0.00 | 0.00 | 0.18 |
| | Total | 62.5±12.7 | 52.7±10 | 0.12 | 45.7±8.8 | 0.00 | 0.29 | 37.6±6.5 | 0.00 | 0.00 | 0.05 |
| Central | 0–2 | 42±12.9 | 34.4±9 | 0.31 | 28.5±6.8 | 0.00 | 0.28 | 21.4±4.8 | 0.00 | 0.00 | 0.02 |
| | 2–6 | 36.9±10.1 | 31±8.7 | 0.42 | 24.9±5.4 | 0.00 | 0.17 | 19.5±3.7 | 0.00 | 0.00 | 0.02 |
| | Total | 38.8±8.3 | 33.9±7.4 | 0.41 | 29.9±5.3 | 0.00 | 0.49 | 23.7±5.1 | 0.00 | 0.00 | 0.01 |
| Posterior | 0–2 | 34.3±11.4 | 28.4±6.1 | 0.36 | 23.7±5.6 | 0.01 | 0.22 | 20.5±3.8 | 0.00 | 0.00 | 0.39 |
| | 2–6 | 29.8±8.5 | 25±7.1 | 0.42 | 21.9±5.2 | 0.02 | 0.70 | 18.2±4.4 | 0.00 | 0.02 | 0.247 |
| | Total | 29.6±7.1 | 25.3±5.7 | 0.33 | 22.4±4.8 | 0.01 | 0.63 | 20.1±4.9 | 0.00 | 0.06 | 0.73 |
| Cornea | 0–2 | 45.4±9.3 | 38.7±6.4 | 0.12 | 34.4±7.2 | 0.00 | 0.47 | 26.8±7.5 | 0.00 | 0.00 | 0.05 |
| | 2–6 | 40.8±6.4 | 35.6±7.6 | 0.26 | 29.7±6.1 | 0.00 | 0.15 | 23.5±5.4 | 0.00 | 0.00 | 0.04 |
| | Total | 41.5±6.5 | 37.3±7.2 | 0.44 | 33.8±6.3 | 0.01 | 0.69 | 28.4±5.4 | 0.00 | 0.00 | 0.11 |

Analyzed by linear mixed model and Sidak method. P1: *P* value when data compared to preoperative, P2: *P* value when data compared to month 1, P3: *P* value of the difference between month 6 and month 3. SD: Standard deviation

**Table 2: Comparison of light backscatter between different layers at different times (*P* value)**

| Layers | Radiuses | Preoperative | Month 1 | Month 3 | Month 6 |
|---|---|---|---|---|---|
| AL versus CL | 2 | 0.00 | 0.00 | 0.00 | 0.00 |
| AL versus PL | | 0.00 | 0.00 | 0.00 | 0.00 |
| CL versus PL | | 0.38 | 0.22 | 0.29 | 0.99 |
| AL versus CL | 6 | 0.00 | 0.00 | 0.00 | 0.00 |
| AL versus PL | | 0.00 | 0.00 | 0.00 | 0.00 |
| CL versus PL | | 0.18 | 0.24 | 0.60 | 0.93 |
| AL versus CL | Total | 0.00 | 0.00 | 0.00 | 0.00 |
| AL versus PL | | 0.00 | 0.00 | 0.00 | 0.00 |
| CL versus PL | | 0.00 | 0.00 | 0.00 | 0.26 |

Analyzed by linear mixed model and Sidak method. AL: Anterior layer, CL: Central layer, PL: Posterior layer

changes in corneal thickness and densitometry can be considered important parameters for the assessment of visual outcome after DSAEK. Furthermore, densitometry values in the central layer can also help explain the optical effects of the DSAEK interface.

The mechanism of corneal densitometry is based on the passage of visible light and lack of backscattering through a healthy cornea.[21] The corneal epithelium and endothelium are the main producers of light scattering, whereas regular and orthogonal arrangement of stromal collagen fibers results in its transparency.[21] In addition to the regular arrangement of stromal components which is dependent on the state of hydration and metabolism of the stromal elements, smoothness of the superficial epithelium and lack of vascularization are important factors to reserve corneal clarity.[29] Disruption of the corneal collagen matrix during edema and the resultant corneal scarring can provoke an increase in corneal light scattering that is clinically identified as corneal haze.[22] This scenario is common in chronic cases of PBK presenting with subepithelial fibrosis.

Application of corneal densitometry on some ocular conditions such as bacterial keratitis, Fuchs' endothelial dystrophy, and keratoconus and following different procedures such as refractive surgery or cross-linking for keratoconus are available in the literature.[30] Moreover, different studies have shown a range of 4–19 with a mean of 12 for densitometries in the normal corneas, and the anterior layer has always had the most density with a mean of about 19.[21,31,32] It could be mentioned that peripheral corneal densitometry values remarkably increase with aging. It seems that corneal densitometry can be an indicator for endothelial cell properties.[31]

Recently, researchers have been attracted to the evaluation of corneal densitometry in keratoplasty cases, and they have reported significant changes in densitometries after keratoplasty, DSAEK and DMEK in particular. In the study presented here, a significant decrease in all three layers was observed after DSAEK, which is consistent with previous studies.[26,33] This decrease in density occurred slowly but significantly, so that the differences did not reach statistical significance at 1 month, but became significant at 3–6 months compared to preoperation time. Furthermore, changes were significant at month 6 compared to month 1, but not compared to month 3. Other studies have reported a significant change after 6 or 12 months that the cornea becomes clear; however, as most of them were retrospective studies, they could not track changes during this period.[26,33,34]

Corneal light backscatter of the anterior layer was significantly higher in our study than the central and posterior layers in 2-mm and 6-mm zones, preoperatively and at all postoperative visits; this finding is consistent with previous studies in the normal and pathologic corneas.[26] Furthermore, corneal light backscatter of each three layers (anterior, central, and posterior) was not statistically different between 0–2 mm and 2–6 mm in all pre- and postoperative visits in this study. A brief review of the recent reports on corneal densitometry in endothelial keratoplasty and relevant details, including number of enrolled eyes, targeted group, type of performed keratoplasty, and results of the studies, are summarized in Supplementary Table 1.

In comparison to previous studies of corneal densitometry in endothelial keratoplasty, our report is one of the only studies evaluating PBK patients. Enrolling complicated cases of PBK with prolonged edema and subepithelial fibrosis is a distinctive aspect of our study since many surgeons schedule penetrating keratoplasty for these cases. In this study, we showed that the improvement of corneal densitometry of patients with subepithelial fibrosis due to PBK through the DSAEK procedure is significant. However, this improvement occurs slowly and during a long period. As expected, we could not find a significant difference between different zones (between 2-mm and 6-mm annuli and between different radial zones), which shows that the course of PBK and clearance after keratoplasty involve the entire cornea equally. Although in endothelial disorders while the main pathology is located at the posterior layer, its effects occur through corneal edema and resultant haze at the central layer and subepithelial changes at the anterior layer. Thus, replacing the diseased endothelium can lead to better transparency of the anterior and central layers of the cornea, not only the posterior. The results of our study were compatible with previous studies in showing this fact.[26,33,34] The short interval for follow-up visits is the other strong point of this study which showed a slow and continued trend in clearance of the cornea after keratoplasty. It is noticeable that the corneas did not reach normal densities up to 6 months of follow-up; this can be justified in several ways: (1) this process is still ongoing and needs further follow-up, (2) some changes in the corneal layers and collagen fibers become irreversible due to long-standing edema, or (3) some miscellaneous factors are influential on our measurements, for example, in the central layer, the interface affects the densitometry, and in the posterior layer, we are actually comparing the preoperative recipient data with the postoperative donor data. Hence, more investigations in corneal densitometry can be helpful for timely surgical intervention, appropriate case selection, and prediction of final outcomes.

Due to the location of the donor rim on about 8 mm, peripheral corneal changes like vascularization and opacities, less repeatability and reproducibility of corneal periphery densitometries,[23] and alterations in light backscattering caused by corneal incision or side ports during the surgery, we excluded data of peripheral radii from our analysis.

Central corneal thickness decreased significantly in our study 3 months after surgery compared to preoperation; however, no significant correlation was observed between densitometric and pachymetric values. This finding has been reported in some other studies and may be because the lenticule thickness differed between patients or due to our small sample size.[40]

Although we had a significant improvement in the visual acuity of our patients, it was not correlated with the corneal densitometry. This finding is contrary to some of the previous studies and can be explained by the fact that many of our patients were elderly and had also undergone previous complicated cataract surgery.[39,40] Hence, age-related retinopathies and neuropathies, maculopathies like cystoid macular edema, or media opacities like capsular opacification may be interfering factors in our study.

Prospective design, enrolling patients with prolonged PBK, and evaluating the effects of DSAEK are the strengths of this study. However, the small sample size and short duration of follow-up visits are the limitations of our study. In addition, it could be better if we had the graft thickness of all cases in the central and peripheral regions, as it can affect the densitometry. It is due to the recipient cornea cannot be evaluated separately with Pentacam Scheimpflug tomography compared to the anterior segment optical coherence tomography.

In conclusion, it seems that corneal densitometry in cases of PBK begins to improve after DSAEK in different layers in a slow and continued trend which can take up to 6 months. Interestingly, this improvement is possible even in complicated and long-standing cases. Hence, corneal densitometry can be used as an objective method for quantification of the outcome of DSAEK in complicated cases of PBK.

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### Conflicts of interest
There are no conflicts of interest.

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**Supplementary Table 1: A brief review of the recent reports on the corneal densitometry in endothelial keratoplasty and issues, including number of enrolled eyes, targeted group, and type of performed keratoplasty**

| Number (reference) | Targeted patients | Type of performed keratoplasty | Preoperative densitometry (0–2 mm) | Final postoperative densitometry (0–2 mm) | Preoperative densitometry (2–6 mm) | Final postoperative densitometry (2-6 mm) | Results |
|---|---|---|---|---|---|---|---|
| 1[26] | FED | 11 DSAEK*<br>16 DMEK* | 39.24±14.69<br>29.82±9.29 | 27.75±12.02<br>21.02±3.36 | 33.00±11.06<br>24.08±7.09 | 27.04±12.39<br>19.98±2.96 | Corneal densitometry of total thickness in 0–2 mm radius remarkably decreased than before<br>Preoperation total densitometry of total thickness and diameter correlated with the postoperative values |
| 2[35] | FED | 152 triple DMEK | Preoperative: 28.43±7.11, final postoperative: 22.28±2.71 (different radiuses were not analyzed) | | | | Central and posterior backscattering values decreased until the 1st year of follow-up<br>Values of posterior backscatter before surgery revealed a correlation with the refractive shift |
| 3[33] | Secondary DMEK after FED | 12 DMEK after DSAEK*<br>11 repeat DMEK*<br>14 primary DMEK* | 48.28±17.04<br>45.16±9.22<br>27.90±8.30 | 22.86±4.88<br>24.53±14.21<br>16.64±1.51 | 42.26±13.87<br>41.86±10.69<br>25.60±9.87 | 20.98±3.89<br>25.04±14.38<br>17.23±4.65 | Zones of 0–2 mm and 2–6 mm showed a remarkable decrease in all of the subgroups<br>Before and 12 months after surgery, corneal densitometry in 0–2 mm and 2–6 mm radiuses of primary DMEK was lower than in secondary groups<br>Light backscatter of secondary DMEK in 0–2 mm radius at 1 year had a correlation with the best-corrected visual acuity<br>No correlation was found between light backscatter and postsurgery central corneal thickness |
| 4[34] | Not reported | 54 DMEK*<br>25 DSAEK* | 34.4±9.4<br>34.0±13.4 | 19.2±2.7<br>21.2±2.5 | 27.8±7.6<br>18.7±2.8 | 30.2±13.3<br>21.4±4.7 | At 3 and 6 months after surgery, central light backscatter in DMEK was lower than DSAEK. This finding was not found at 12 and 24 months<br>Postoperative light backscatter in DSAEK was higher than in healthy controls<br>Postoperative light backscatter in DMEK was higher than controls at 3, 6, and 12 but not at 24 months |
| 5[36] | 88 FED<br>12 PBK | 100 DMEK*<br>20 age-matched pseudophakic eyes*<br>30 healthy young controls* | 33.9±10.7<br>N/A<br>N/A | 20.3±4.7<br>18.1±1.3<br>16.9±1.0 | 27.9±8.1<br>N/A<br>N/A | 20.2±4.6<br>18.1±2.6<br>15.4±1.0 | Although total light backscatter in a radius of 0–2 mm decreased after DMEK, it was higher than both control groups |
| 6[37] | DMEK cases | 32 DMEK cases followed by rebubbling*<br>55 uncomplicated DMEK cases with graft attachment*<br>25 uncomplicated DMEK cases with minor peripheral detachment not requiring rebubbling* | 32.3±8.3<br>37.0±11.9<br>32.5±8.8 | 21.2±3.5<br>19.4±3.0<br>19.8±3.1 | 27.5±6.4<br>30.2±9.2<br>26.3±6.2 | 20.8±3.4<br>19.6±3.6<br>19.2±3.1 | No significant differences between the three groups were found at any time of assessment<br>At 3 months, paracentral light backscatter of uncomplicated DMEK cases was significantly lower than cases required rebubbling |

*Contd...*

**Supplementary Table 1: Contd...**

| Number (reference) | Targeted patients | Type of performed keratoplasty | Preoperative densitometry (0–2 mm) | Final postoperative densitometry (0–2 mm) | Preoperative densitometry (2–6 mm) | Final postoperative densitometry (2-6 mm) | Results |
|---|---|---|---|---|---|---|---|
| 7[38] | 5 PBK<br>120 FECD | DSAEK | N/A | | | | Light backscatter is determining for visual outcome of DSAEK |
| 8[39] | FED | 160 DMEK | N/A | | | | Light backscatter of all layers decreased after the DMEK procedure over 2 years<br>Corneal densitometry of 0–2 mm in all layers decreased more than 2–10 mm at 12 and 24 months |
| 9[40] | 369 FED<br>37 PBK<br>6 PEX keratopathy | DMEK | 34.0±10.8 | N/A | 29.6±9.5 | N/A | Corneal densitometry correlated with preoperative visual acuity |
| 10 (presenting report) | 21 Complicated PBK | DSAEK | 45.4±9.3 | 26.8±7.5 | 40.8±6.4 | 23.5±5.4 | There was a significant difference in corneal densitometry between AL with CL and PL in 2 mm and 6 mm zones<br>Corneal densitometry measures significantly decreased in all three layers (anterior, central, and posterior) 3 and 6 months after surgery compared to preoperative values<br>No significant difference between the different zones (between 2-mm and 6-mm annuli and between different radial zones) |
| 11[32] | Normal eyes | - | OD: 16.76±1.87<br>OS: 16.70±1.84 | | OD: 15.81±1.97<br>OS: 15.64±1.86 | | - |

*Articles whose results are significant. DSAEK: Descemet stripping automated endothelial keratoplasty, DMEK: Descemet membrane endothelial keratoplasty, PBK: Pseudophakic bullous keratopathy, PEX: Pseudoexfoliation syndrome, N/A: Not available, FED: Fuchs' endothelial dystrophy, OD: Right eye, OS: Left eye