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Original Research

Comparative Study of Visual Outcomes in Penetrating Keratoplasty vs Descemet's Stripping Endothelial Keratoplasty

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ABSTRACT:

Aim: To compare the visual outcomes, complication rates, and endothelial cell preservation between Penetrating Keratoplasty (PK) and Descemet's Stripping Endothelial Keratoplasty (DSEK) in patients with corneal endothelial dysfunction. **Material and Methods:** This prospective, comparative observational study was conducted over 18 months at a tertiary care center with 100 patients diagnosed with corneal endothelial dysfunction. Patients were randomly divided into two groups: Group A (n=50) underwent Penetrating Keratoplasty and Group B (n=50) underwent Descemet's Stripping Endothelial Keratoplasty. Visual acuity (BCVA), endothelial cell density (ECD), and postoperative complications were assessed at 1, 3, and 6 months postoperatively. **Results:** Both groups were comparable in baseline demographics and surgical indications. At 6 months, mean BCVA was significantly better in the DSEK group (0.30 ± 0.18 LogMAR) than in the PK group (0.55 ± 0.20 LogMAR; $p< 0.001$). Endothelial cell density was also higher in DSEK (1960 ± 120 cells/mm²) compared to PK (1700 ± 135 cells/mm²; $p< 0.001$). Although graft rejection (12% in PK vs 4% in DSEK) and other complications were more common in PK, the differences were not statistically significant. **Conclusion:** DSEK offers significantly better visual recovery and endothelial cell preservation than PK, with fewer complications, making it a safer and more effective surgical approach for endothelial dysfunction.

Keywords: Descemet's Stripping Endothelial Keratoplasty, Penetrating Keratoplasty, Visual Acuity, Endothelial Cell Density, Corneal Transplantation

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INTRODUCTION

Corneal endothelial dysfunction is a leading cause of visual impairment worldwide, particularly in older adults. It often arises due to conditions such as Fuchs' endothelial dystrophy, pseudophakic bullous keratopathy, trauma, or failure of a previous corneal graft. These disorders compromise the endothelial layer of the cornea, which plays a critical role in maintaining corneal transparency through its pump and barrier functions. As the endothelium becomes damaged or dysfunctional, corneal edema ensues, leading to blurred vision, glare, and ultimately visual disability. Surgical intervention remains the primary treatment modality for such endothelial pathologies, with corneal transplantation procedures offering an opportunity to restore vision.[1]

Over the years, advancements in corneal surgery have significantly evolved the management of endothelial dysfunction. Traditionally, Penetrating Keratoplasty (PK), which involves full-thickness replacement of the diseased cornea with a donor graft, was considered the gold standard. PK has been widely practiced for decades and has demonstrated efficacy in improving visual acuity. However, it carries several inherent limitations, including delayed visual rehabilitation, higher risk of graft rejection, and compromised structural integrity due to the full-thickness nature of the transplant.[2]

In contrast, newer lamellar keratoplasty techniques have emerged, offering more targeted approaches. Among these, Descemet's Stripping Endothelial Keratoplasty (DSEK) has gained popularity as a less invasive and more physiologically sound alternative. DSEK involves selective removal and replacement of the diseased Descemet's membrane and endothelium, leaving the patient's anterior corneal stroma and

epithelium intact. This approach not only preserves the biomechanical strength of the cornea but also results in a smaller wound, fewer sutures, reduced postoperative astigmatism, and a faster visual recovery.[3]

The shift from full-thickness to selective endothelial replacement surgery represents a paradigm change in the management of corneal diseases. However, despite the growing adoption of DSEK, Penetrating Keratoplasty continues to be performed in specific clinical scenarios, especially when there is significant stromal scarring, coexisting anterior segment abnormalities, or a history of multiple failed grafts. Therefore, both PK and DSEK remain important surgical options in contemporary ophthalmology, and a comparative understanding of their visual outcomes is essential for informed surgical decision-making.[4]

Visual rehabilitation is a primary goal in corneal transplantation. While both PK and DSEK aim to restore visual acuity, the quality and timeline of recovery, incidence of complications, and long-term graft survival vary between the two techniques. PK often results in a longer visual recovery period, taking several months to a year for stable and optimal outcomes due to the reliance on suture stabilization, postoperative astigmatism, and slow wound healing. Additionally, the visual acuity in PK may be limited by irregular astigmatism and higher-order aberrations resulting from the large corneal incision.[5]

On the other hand, DSEK patients typically experience more rapid visual improvement, often within weeks, owing to the smaller incision size and preservation of the corneal architecture. Moreover, the incidence of complications such as wound dehiscence and suture-related issues is significantly lower in DSEK. Nonetheless, DSEK is not without its own set of challenges, including the risk of graft dislocation, interface haze, and a learning curve for surgeons transitioning from PK to lamellar techniques.[6]

Comparative studies evaluating these procedures offer valuable insights into their relative advantages and limitations. Parameters such as best corrected visual acuity (BCVA), uncorrected visual acuity (UCVA), graft survival rates, endothelial cell loss, refractive outcomes, and postoperative complications serve as key indicators of surgical success. Understanding these variables is particularly crucial when tailoring treatment to individual patient needs, taking into account their age, ocular comorbidities, lifestyle requirements, and ability to adhere to postoperative care.

In clinical practice, patient preference, anatomical considerations, and surgeon expertise play significant roles in choosing between PK and DSEK. For instance, in eyes with relatively clear anterior stroma and isolated endothelial failure, DSEK is often the preferred approach. Conversely, in cases where corneal opacity involves all layers or where the anterior segment anatomy is severely distorted, PK may still be indicated. Furthermore, advancements in DSEK, such as ultra-thin and pre-loaded grafts, have further improved its outcomes and broadened its applicability.[7]

This study seeks to compare the visual outcomes following Penetrating Keratoplasty and Descemet's Stripping Endothelial Keratoplasty in patients with corneal endothelial dysfunction. By assessing visual acuity, graft clarity, and complication profiles over a defined follow-up period, the research aims to provide a comprehensive analysis of the effectiveness and safety of these procedures. Such comparative evaluation will not only contribute to the current body of evidence but also assist in optimizing surgical planning and patient counseling for corneal transplant candidates.

MATERIAL AND METHODS

This prospective, comparative observational study was conducted in the Department of Ophthalmology at a tertiary care center over a period of 18 months, following approval from the Institutional Ethics Committee. A total of 100 patients diagnosed with corneal endothelial dysfunction requiring surgical intervention were enrolled after obtaining written informed consent. The study aimed to evaluate and compare the visual outcomes following Penetrating Keratoplasty (PK) and Descemet's Stripping Endothelial Keratoplasty (DSEK).Patients were included based on the following criteria: age between 20-80 years, presence of corneal endothelial decompensation due to conditions such as pseudophakic bullous keratopathy, Fuchs' endothelial dystrophy, or failed previous grafts, and the ability to maintain regular follow-up for a minimum of 6 months. Exclusion criteria included eyes with active ocular inflammation or infection, glaucoma with optic nerve damage, retinal pathology affecting vision, significant anterior segment abnormalities, and systemic conditions contraindicating surgery.

The selected patients were randomly allocated into two equal groups using a computer-generated randomization table. Group A (n=50) underwent conventional Penetrating Keratoplasty, wherein a full-thickness corneal transplant was performed under local or general anesthesia using a standard trephination technique. Donor buttons were selected based on corneal thickness and endothelial cell count and were secured using 10-0 nylon interrupted and continuous sutures. Postoperatively, patients were treated with topical corticosteroids, antibiotics, and lubricants, with regular follow-up for suture management and assessment of graft clarity.

Group B (n=50) underwent Descemet's Stripping Endothelial Keratoplasty. In this procedure, the host Descemet's membrane and endothelium were stripped using a reverse Sinskey hook through a temporal clear corneal incision. A pre-cut donor lenticule containing healthy endothelium was prepared and introduced into the anterior chamber using a glide or injector system. An air bubble was used to press the graft against the

host stroma, ensuring adherence. Postoperative care included supine positioning for at least 2 hours, along with topical steroids and antibiotics.

All patients underwent standardized postoperative evaluations at 1 week, 1 month, 3 months, and 6 months. Best corrected visual acuity (BCVA) was recorded using Snellen's chart and converted to LogMAR units for statistical analysis. Additional parameters including graft clarity, endothelial cell count (by specular microscopy), postoperative complications, and need for rebubbling or regrafting were also noted and compared between both groups.

Data was compiled and analyzed using SPSS software. Categorical variables were compared using the Chi-square test, while continuous variables were analyzed using Student's t-test or Mann-Whitney U test depending on data distribution. A p-value of <0.05 was considered statistically significant.

RESULTS

In the present study, a total of 100 patients undergoing corneal transplant surgeries for endothelial dysfunction were equally divided into two groups: Group A (Penetrating Keratoplasty - PK) and Group B (Descemet's Stripping Endothelial Keratoplasty - DSEK). The demographic characteristics of the patients, as shown in Table 1, revealed no statistically significant differences between the two groups. The mean age of patients in Group A was 58.6 ± 12.1 years, while it was 56.2 ± 11.7 years in Group B (p = 0.28). The gender distribution was also comparable with a male-to-female ratio of 28:22 in the PK group and 27:23 in the DSEK group (p = 0.84). Similarly, the distribution of right and left eyes was balanced in both groups (26:24 in PK vs 25:25 in DSEK, p = 0.89). This homogeneity ensures the baseline comparability of the groups for further outcome analysis.

Table 2 outlines the underlying indications for surgical intervention. The most common indications across both groups were pseudophakic bullous keratopathy (PK: 20 cases, DSEK: 22 cases) and Fuchs' endothelial dystrophy (PK: 18 cases, DSEK: 19 cases), highlighting these as leading causes of endothelial dysfunction necessitating keratoplasty. A smaller number of cases were due to failed previous grafts and other less common causes, such as trauma or keratitis. The similarity in distribution of indications further strengthens the comparability of the groups.

Postoperative visual outcomes, assessed using best corrected visual acuity (BCVA) in LogMAR units and summarized in Table 3, demonstrated a clear and statistically significant advantage for the DSEK group at all follow-up intervals. At 1 month, the mean BCVA in the PK group was 0.90 ± 0.25, whereas it was significantly better in the DSEK group at 0.75 ± 0.22 (p = 0.01). This trend continued at 3 months (PK: 0.70 ± 0.24 vs DSEK: 0.45 ± 0.21, p< 0.001) and at 6 months (PK: 0.55 ± 0.20 vs DSEK: 0.30 ± 0.18, p< 0.001). These findings indicate that DSEK patients not only achieved better visual outcomes but also experienced faster visual recovery.

The incidence of postoperative complications, shown in Table 4, was higher in the PK group compared to DSEK, although the differences were not statistically significant. Graft rejection occurred in 12% of PK cases compared to 4% in the DSEK group (p = 0.14). Similarly, elevated intraocular pressure was noted in 14% of PK cases and 6% of DSEK cases (p = 0.19). Graft failure and the need for surgical re-intervention were also more frequent in the PK group (8% and 10%, respectively) than in the DSEK group (2% and 4%, respectively). Although these results were not statistically significant, they suggest a trend toward better graft stability and fewer complications with DSEK.

Finally, Table 5 presents the endothelial cell density (ECD) before surgery and at 6 months postoperatively. Preoperative ECD was similar in both groups (PK: 2420 ± 120 vs DSEK: 2450 ± 110, p = 0.10), ensuring equivalent starting points. However, at 6 months, the DSEK group retained significantly more endothelial cells (1960 ± 120) compared to the PK group (1700 ± 135), with a highly significant p-value (<0.001). This finding is important as it correlates with long-term graft survival and corneal clarity, further emphasizing the superiority of DSEK in preserving endothelial function.

Table 1: Demographic Distribution of Study Participants

Parameter	Group A (PK) (n=50)	Group B (DSEK) (n=50)	p-value
Mean Age (years)	58.6 ± 12.1	56.2 ± 11.7	0.28
Male : Female Ratio	28 : 22	27 : 23	0.84
Laterality (Right/Left)	26 / 24	25 / 25	0.89

Table 2: Indications for Surgery

Indication	Group A (PK) (n=50)	Group B (DSEK) (n=50)
Pseudophakic Bullous Keratopathy	20	22
Fuchs' Endothelial Dystrophy	18	19
Failed Previous Graft	7	6
Others	5	3

Table 3: Visual Acuity (BCVA) in LogMAR at Different Follow-ups

Follow-up Duration	Group A (PK) Mean ± SD	Group B (DSEK) Mean ± SD	*p*-value
1 Month	0.90 ± 0.25	0.75 ± 0.22	0.01*
3 Months	0.70 ± 0.24	0.45 ± 0.21	<0.001*
6 Months	0.55 ± 0.20	0.30 ± 0.18	<0.001*

Table 4: Postoperative Complications

Complication	Group A (PK) (n=50)	Group B (DSEK) (n=50)	*p*-value
Graft Rejection	6 (12%)	2 (4%)	0.14
Elevated IOP	7 (14%)	3 (6%)	0.19
Graft Failure	4 (8%)	1 (2%)	0.17
Need for Re-intervention	5 (10%)	2 (4%)	0.23

Table 5: Endothelial Cell Density (cells/mm²)

Time Point	Group A (PK) Mean ± SD	Group B (DSEK) Mean ± SD	*p*-value
Preoperative	2420 ± 120	2450 ± 110	0.10
6 Months Post-op	1700 ± 135	1960 ± 120	<0.001*

DISCUSSION

The comparable demographic characteristics in this study, including mean age, gender distribution, and laterality, support the validity of the comparative outcomes between PK and DSEK. Similar baseline characteristics were observed in a study by Terry et al. (2007), where the age and gender distribution of patients undergoing DSEK and PK for endothelial dysfunction did not differ significantly, thereby ensuring fair comparison of surgical outcomes. In our study, the mean age was 58.6 ± 12.1 years in the PK group and 56.2 ± 11.7 years in the DSEK group, consistent with the demographic range reported by Terry et al., reinforcing that age and sex do not act as confounding variables in evaluating visual recovery.[8]

Regarding the indications for surgery, pseudophakic bullous keratopathy and Fuchs' endothelial dystrophy were the most frequent causes of corneal endothelial dysfunction in our cohort. This is in line with the findings of Gorovoy et al. (2006), who also reported these two conditions as the most common indications for DSEK in their clinical series. In our study, 20 patients in the PK group and 22 in the DSEK group had pseudophakic bullous keratopathy, while Fuchs' dystrophy was noted in 18 and 19 patients, respectively. The close alignment in distribution of these indications supports the external validity of our findings.[9]

A significant difference in visual recovery was observed between the two groups, favoring DSEK. At 6 months, the mean BCVA in the DSEK group was 0.30 ± 0.18 LogMAR compared to 0.55 ± 0.20 LogMAR in the PK group ($p< 0.001$). These findings are corroborated by the work of Price et al. (2009), who reported that patients undergoing DSEK attained a mean visual acuity of 0.32 LogMAR at 6 months, whereas PK patients achieved only 0.54 LogMAR, which aligns closely with our study outcomes. Their study emphasized the advantage of DSEK in providing faster and better visual rehabilitation compared to PK.[10]

The complication profile also favored DSEK in our study. While graft rejection occurred in 12% of PK cases, it was only 4% in the DSEK group. Graft failure was also more frequent in PK (8%) than in DSEK (2%). These observations are in agreement with the findings of Lee et al. (2010), who reported a higher incidence of rejection and failure in full-thickness grafts due to a larger antigenic load and prolonged wound healing, whereas DSEK exhibited better immunologic tolerance and faster structural recovery. Their data demonstrated rejection rates of 11.5% in PK versus 3.5% in DSEK, closely mirroring the pattern seen in our study.[11]

Endothelial cell survival is another critical indicator of graft longevity. At 6 months, we noted that DSEK preserved a significantly higher endothelial cell density (1960 ± 120 cells/mm²) than PK (1700 ± 135 cells/mm²), ($p< 0.001$). Similar findings were documented by Melles et al. (2008), who emphasized that DSEK minimizes surgical trauma to the endothelium, resulting in better postoperative cell survival. They reported a 6-month ECD of approximately 1950 cells/mm² in DSEK cases, strongly supporting the consistency and reproducibility of our data.[12]

Overall, our study highlights that DSEK is a superior technique for patients with endothelial dysfunction in terms of visual outcomes, lower complication rates, and better preservation of endothelial cells. These findings are consistent with the comparative review by Bhandari et al. (2011), who concluded that while PK remains a viable option in complex or combined cases, DSEK offers significant advantages in uncomplicated endothelial pathology. Their review summarized multiple trials indicating improved functional outcomes and lower rejection rates with DSEK, echoing the trends we observed in this cohort.[13]

CONCLUSION

This study demonstrates that Descemet's Stripping Endothelial Keratoplasty (DSEK) offers superior

outcomes compared to Penetrating Keratoplasty (PK) in patients with corneal endothelial dysfunction. DSEK provided significantly better visual acuity, faster recovery, and greater endothelial cell preservation at 6 months postoperatively. Although complication rates were higher in the PK group, the differences were not statistically significant. Overall, DSEK proves to be a safer and more effective surgical option for endothelial pathologies, with enhanced functional and anatomical success.

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