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# Clinical outcomes of Descemet's stripping endothelial keratoplasty using a manual or automated procedure at Undaan Eye Hospital Surabaya, Indonesia: with one-year follow up

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## ABSTRACT

**Background:** Endothelial keratoplasty (EK) is a selective lamellar corneal transplantation technique that replaces damaged endothelium while preserving the patient's corneal stroma. Donor graft preparation can be done using Descemet stripping endothelial keratoplasty (DSEK) or Descemet stripping automated endothelial keratoplasty (DSAEK). Research on EK in Indonesia is currently underreported, but it is crucial for developing strategies to treat corneal blindness in the future. This study aimed to present visual acuity, graft survival, and complications after DSEK or DSAEK at Undaan Eye Hospital Surabaya.
**Methods:** This study involved 17 eyes, treated with DSEK or DSAEK surgery between 2017 and 2022. Patients with other ocular diseases and incomplete medical records were excluded. Best corrected visual acuity (BCVA) was documented before the surgery, and at 1 day, 1, 3, 6 months, and 1 year after. Data in this study were analyzed using multiple techniques, including Wilcoxon, Kaplan-Meier survival, and bivariate logistic regression analysis.
**Results:** The postoperative mean BCVA significantly increased to 1.36 ± 0.57 logMAR (p=0.012) at 1 day, 1.02 ± 0.62 logMAR (p=0.002) at 1 month, 0.94 ± 0.66 logMAR (p=0.002) at 3 months, 0.72 ± 0.66 logMAR at 6 months (p=0.000), and 0.74 ± 0.74 logMAR (p=0.001) at 1-year compared to preoperative BCVA of 1.84 ± 0.39 logMAR. The graft could survive 100% within 1 day to 6 months and 76% within 1 year after surgery. Bivariate logistic regression showed donor origin had a statistically significant effect with p-value = 0.031 and odds ratio = 1.8, 95% confidence interval (CI) = 1.003 - 3.229. Corneal edema was the most common complication in the early and late postoperative periods.
**Conclusion:** DSEK or DSAEK surgery is safe, effective, and viable. It shows good visual outcomes and becomes the most used EK treatment for corneal endothelial dysfunction.

**Keywords:** DSEK, DSAEK, lamellar keratoplasty, corneal endothelial dysfunction.
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## INTRODUCTION

Endothelial keratoplasty (EK) is a popular selective process for replacing the dysfunctional corneal endothelium when this is the only area of the cornea that is affected.[1,2] Blindness may result from conditions like bullous keratopathy (BK) or Fuchs' endothelial corneal dystrophy (FECD), which cause irreversible corneal edema. EK's popularity can be attributed to several factors. First, unlike penetrating keratoplasty (PK), a surgeon can easily adopt this technique and has superior wound strength and postoperative patient comfort. In addition, it offers better visual function, lighter astigmatism, and more successful graft survival. Finally, the patient's visual recovery is faster without extensive suture removal. For these reasons, EK is more favorable among people suffering corneal endothelial impairment.[1,3]

Descemet stripping endothelial keratoplasty (DSEK), Descemet stripping automated endothelial keratoplasty (DSAEK), and Descemet membrane endothelial keratoplasty (DMEK) are surgical methods for EK. Of these three methods, DSAEK has been used widely worldwide because it has achieved significant acceptance for dysfunctional corneal endothelial treatment.[2,4] In DSAEK, an automated microkeratome dissects the deep stroma without touching the endothelium.[2,5] However, manual dissection can also be used to prepare the tissue. This process is known as DSEK.[6] The last method is DMEK, the latest development in surgical partial corneal transplantation. However, DMEK has received less popularity mainly due to the higher learning curve and technically challenging.[7]

To the best of our knowledge, research about EK in Indonesia is still underreported. Aditia *et al.* conducted research at Undaan Eye Hospital Surabaya from 2017 to 2020, and Siregar *et al.* carried out similar research in Jakarta from 2014 to 2018. They reported that DSAEK was still the second most common technique after PK, with the leading indication being bullous keratopathy.[8,9] In fact, research about EK is important as a basis for strategies to treat corneal blindness in the future. We then attempted to fill the gap

by reporting our experience with DSEK or DSAEK at Undaan Eye Hospital Surabaya. We examined this surgery by looking at the visual outcomes, graft survival, and complications after DSEK or DSAEK surgery.

## METHODS

This study was performed at Undaan Eye Hospital in Surabaya from May 2017 to August 2022. Patients with incomplete medical records and other ocular comorbidities were excluded. To increase data reliability, all DSEK and DSAEK operations were executed by the same surgeon. The researchers have informed all patients about this research project and obtained their written consent before performing the surgery. In addition, the ethical review has been submitted to the Health Research Ethic Committee, Ibnu Sina Regional Public Hospital, with approval number 071/007/437.76/2023.

This study recorded best corrected visual acuity (BCVA) using a digital Snellen chart multiple times. First, it was assessed before the surgery. It was re-recorded at 1 day, 1, 3, 6 months, and 1 year after surgery. They were conducted at the same location with the same equipment during the study period. The Wilcoxon test was then taken to evaluate BCVA improvement between the time intervals. Nominal data were presented as numbers and percentages. Meanwhile, the continuous data were reported as the means and standard deviation (SD) with a 95% confidence interval (CI). Following that, the study used a Kaplan-Meier method to calculate cumulative rates of donor graft survival. Finally, a log-rank test aimed to identify clinical factors that affected graft survival after DSEK or DSAEK surgery. The data were analyzed through bivariate logistic regression, calculating the incidence OR with 95% CIs. If the p-value achieved in the analysis was lower than 0.05, it was considered statistically significant. The significance level was set to $p < 0.05$. Data were analyzed with SPSS 25.

## RESULTS

The study evaluated 17 eyes of 17 patients. Patients' ages ranged from 39 to 82 years old. Details of the patients' general information are illustrated in Table 1.

**Table 1. Clinical characteristics**

| Variables | | n | % |
|---|---|---|---|
| Age | < 65 | 13 | 76.5% |
| | > 65 | 4 | 23.5% |
| Sex | Female | 9 | 52.9% |
| | Male | 8 | 47.1% |
| PBK | | 12 | 70.6% |
| ABK | | 2 | 11.8% |
| BK | | 16 | 94.1% |
| Fuchs Dystrophy | | 1 | 5.9% |
| ICE Syndrome | | 1 | 5.9% |
| Senile Cataract | | 1 | 5.9% |
| Complicated Cataract | | 1 | 5.9% |
| EK | DSEK | 2 | 11.8% |
| | DSAEK | 15 | 88.2% |
| (Combined) SICS + Primary IOL | | 1 | 5.9% |
| (Combined) PE + Primary IOL | | 1 | 5.9% |
| (Combined) Secondary IOL Scleral Fixation | | 1 | 5.9% |
| (Combined) Secondary IOL Claw Lens | | 2 | 11.8% |
| (Combined) Iridoplasty | | 3 | 17.6% |
| Donor Origin | Local | 9 | 52.9% |
| | Import | 8 | 47.1% |

*Significant at level 0.05.

*BK, Bullous Keratopathy; PBK, Pseudophakic Bullous Keratopathy; ABK, Aphakic Bullous Keratopathy; ICE Syndrome, Iridocorneal Endothelial Syndrome; SICS, Small Incision Cataract Surgery; IOL, Intraocular Lens; PE, Phacoemulsification.*

**Table 2. Preoperative and postoperative mean of BCVA**

| | No | Best Corrected Visual Acuity | | | P |
|---|---|---|---|---|---|
| | | Minimum | Maximum | Mean | |
| Before surgery | 17 | 2.47 | 1.30 | 1.84 | Referent |
| Postoperative day 1 | 17 | 2.47 | 0.39 | 1.36 | 0.027* |
| Postoperative month 1 | 17 | 2.47 | 0.22 | 1.02 | 0.002* |
| Postoperative month 3 | 17 | 2.47 | 0.15 | 0.94 | 0.001* |
| Postoperative month 6 | 17 | 2.47 | 0.04 | 0.72 | 0.000* |
| Postoperative year 1 | 17 | 2.47 | 0.00 | 0.74 | 0.001* |

*Significant with a p-value less than 0.05. Each *P* value above indicates the Wilcoxon test's result. The test compared the time point's mean best spectacle-corrected visual acuity with the mean best spectacle-corrected visual acuity from the previous time point.

Table 2 and Figure 1 provide BCVA's mean and range of 17 patients observed in this study. The study found that the mean of BCVA tended to improve and moved to a statistically significant trend. The trend improved especially within 1 day, 1, 3, 6 months, and 1 year after surgery. While BCVA before surgery was all under 1.30 logMar, the mean BCVA within 1 year was 0.74 ± 0.74 logMAR.

We used bivariate logistic regression analysis to calculate the risk factors between the clinical factors and 1-year outcomes after DSEK/DSAEK surgery. We found a significant relationship between donor origin and outcomes after 1-year follow-up with a p-value < 0.05. As illustrated in Table 3, import donors have a probability of 1.8 times better outcomes compared to local donors, with a value of p=0.031 (odds ratio = 1.8, 95% confidence interval (CI) = 1.003 to 3.229).

Another key finding was the rate of donor graft survival. Figure 2A reveals that the rates of survival within 1 day, 1 month, 3 months, and 6 months are 100%. Meanwhile, the rate is 76% for 1 year after surgery. The cumulative graft survival rate at 1 year between FECD and BK was comparable with a p-value of 0.589 (log-rank test).

Regarding complications, Figure 3 indicates that there are soft eyes and

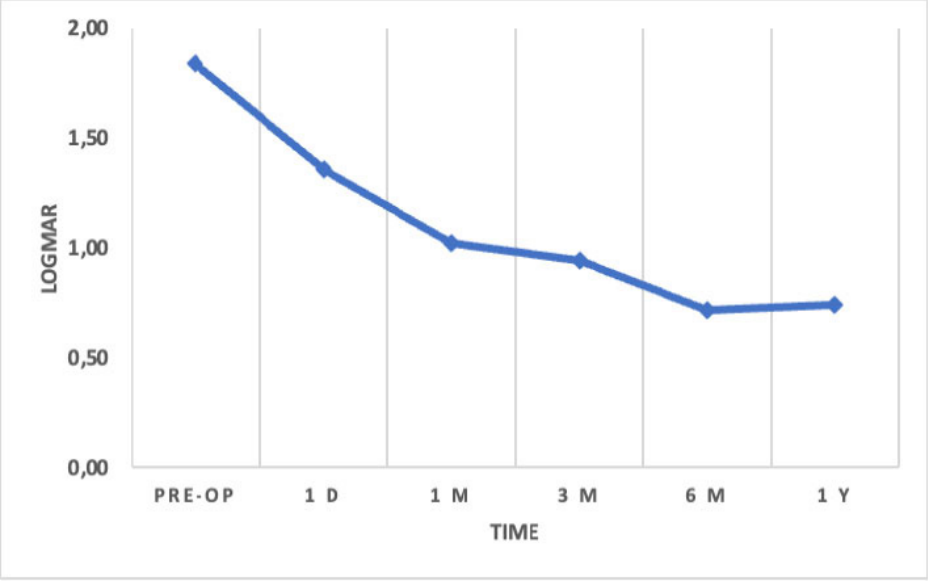


**Figure 1.** Graph showing improvement of BCVA.

**Table 3. Bivariate ORs of clinical factors**

| Clinical Factors | Bivariate analysis | |
|---|---|---|
| | Sig. | OR (CI 95%) |
| Age | 0.205 | 0.692 (0.482-0.995) |
| Sex | 0.200 | 0.208 (0.017-2.600) |
| BK | 0.347 | 0.250 (0.012-5.262) |
| PBK | 0.825 | 0.750 (0.058-9.618) |
| ABK | 0.404 | 0.733 (0.540-0.995) |
| Fuchs dystrophy | 0.567 | 0.750 (0.565-0.995) |
| ICE syndrome | 0.567 | 0.750 (0.565-0.995) |
| DSEK | 0.404 | 0.733 (0.540-0.995) |
| DSAEK | 0.404 | 1.364 (1.005-1.850) |
| Combined with SICS + Primary IOL | 0.063 | 0.188 (0.068-0.520) |
| Combined with PE + IOL | 0.567 | 0.750 (0.565-0.995) |
| Combined with Secondary IOL Scleral Fixation | 0.567 | 0.750 (0.565-0.995) |
| Combined with Secondary IOL Claw Lens | 0.347 | 0.250 (0.012-5.262) |
| Combined with Iridoplasty | 0.659 | 0.545 (0.036-8.270) |
| Donor origin | 0.031* | 1.800 (1.003-3.229) |

*Significant with a p-value less than 0.05. BK, Bullous Keratopathy; PBK, Pseudophakic Bullous Keratopathy; ABK, Aphakic Bullous Keratopathy; ICE Syndrome, Iridocorneal Endothelial Syndrome; SICS, Small Incision Cataract Surgery; IOL, Intraocular Lens; PE, Phacoemulsification

iridodialysis in case of intraoperative complications. The intraoperative problems may occur during donor preparation, recipient preparation, and graft insertion and unfolding. As shown in the Figure, the most common early and late postoperative complications were corneal edema 11.8% and 23.5%.

## DISCUSSION

This study showed that visual acuity gradually improved after surgery at each follow-up time. Many studies, for example Price et al, Koenig et al, and Li et al, revealed that patients receiving DSAEK surgery experienced an early improvement in visual acuity. After excluding eyes with retinal illness or amblyopia, Price and Price found that the mean of BCVA consistently increased within 1 to 6 months. They reported that more than three-quarters of eyes could see 0.5 or better at that point. Similar results were reported by Koenig et al. According to them, more than half of their participants' eyes had a BCVA of 0.5 or better at 6 months following DSAEK surgery. Within 1 semester after DSAEK surgery, 94.4% of the 108 eyes studied by Li et al had a BCVA of 0.5 or above. One study reported the rate of visual recovery was extremely rapid after macula or optic nerve pathology was eliminated. Over 80% of patients achieved a BSCVA of 0.5 by 6 weeks and increased to over 90% by 3 months, with one-third usually reaching 20/25 in the first 6 months.[1,10-12]

BCVA initially improves because the damaged endothelium and corneal guttae are removed during EK surgery. As a result, corneal edema decreases.[13] During this initial postoperative phase, the long-term visual acuity limitation and plateau are most likely multifactorial. Even after a successful EK procedure, evidence suggests that light scattering can be brought on by lingering alterations in the host cornea's stroma and subepithelial area.[13,14] Moreover, poor visual acuity after surgery has been linked to donor tissue folds or wrinkles that result in abnormalities in the posterior corneal surface.[15] This study is significant because it notice a tendency of BCVA improvement up to 1 year after DSAEK surgery.

The study found that visual outcomes among some DSAEK eyes were different. This is probably because the host and donor tissues have a distinct optical architecture of the corneal stromal layers. It has been noted that even patients with an interface that appears clear do not always attain a BCVA of 0.0 logMAR (20/20) after DSAEK surgery. Patel et al.[13] showed that the lamellar interface after EK surgery creates a slight increase in corneal backscatter.

However, in comparison with those studies,[1,10-12] the visual acuity outcome in this study was less satisfactory. The present study included 17 eyes, and the mean postoperative BCVA of 41.17 % reached 0.5 (logMAR 0.30). Better BCVA by achieved within 6 months after DSAEK surgery. Compared to other countries, Indonesia has fewer donors. Corneal haze frequently occurred after a long period of waiting and was a factor in the poorer visual results.

This retrospective analysis examined patients' graft survival after surgery in consecutive individuals with FECD and BK. The majority of earlier research on the surgical results following DSEK or

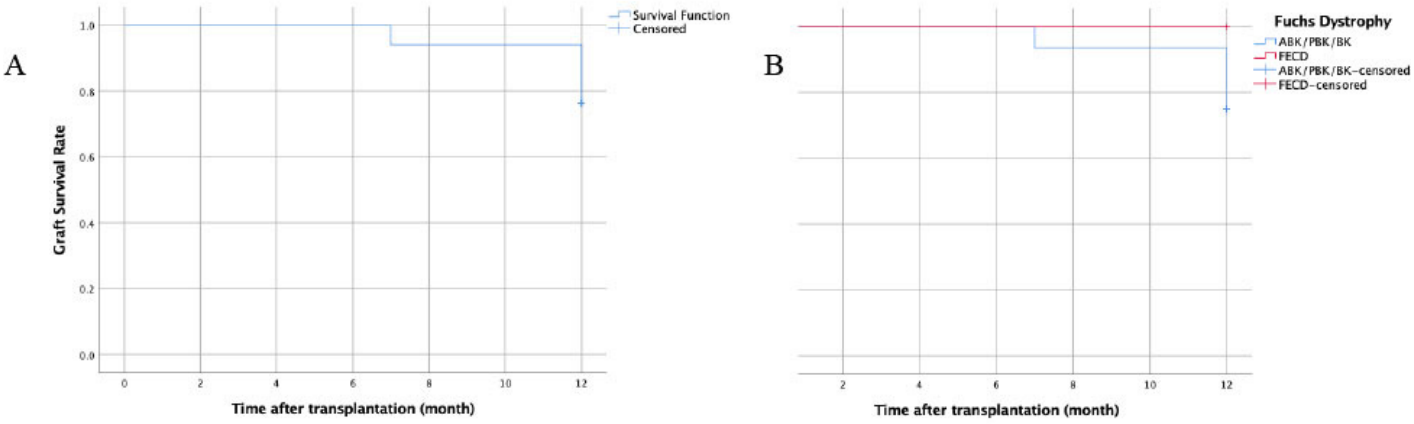


**Figure 2.** A). A cumulative Kaplan-Meier graft survival curve in total eyes, and B). Two different groups, including FECD and BK.

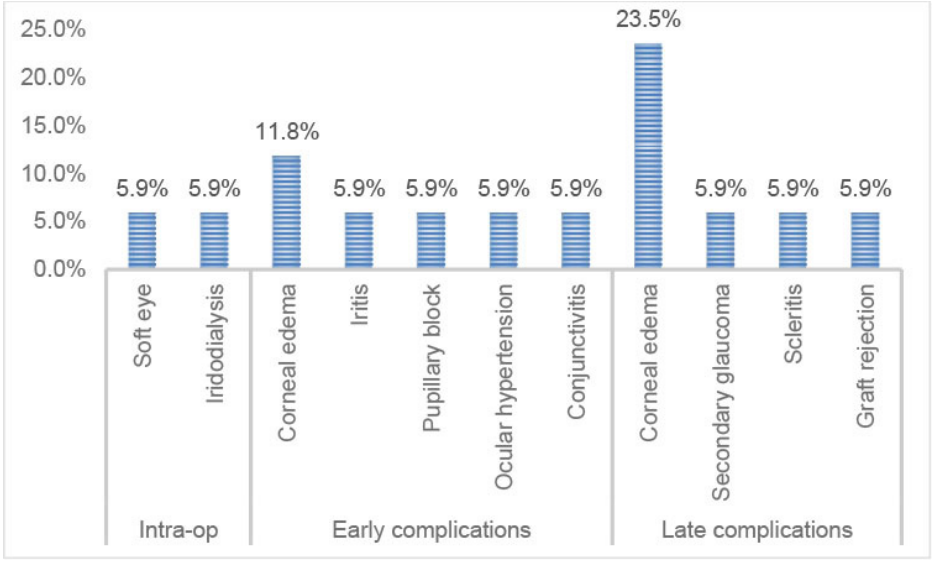


**Figure 3.** Intra-operative, early, and late complications.

DSAEK has mostly examined patients with FECD. Hence, these findings sharpen our knowledge about the short-term outcomes of the operations after DSEK or DSAEK. These were usually caused by factors requiring surgery, such as PBK, ABK, and Phakic BK. There were also other ocular diseases, including ICE syndrome and endothelins.[3,16]

After 1 year of follow-up, this study reported a relatively lower graft survival (76%) than other studies (84%, 94.1%, 95%, and 99%).[3,16] Although graft survival does not necessarily correspond with endothelium function, endothelial cell loss is nonetheless a significant side effect of corneal transplantation as a marker of impending endothelial failure. From published literature, various graft failures in EK were associated with unsatisfactory BCVA compared to expected visual potential, immunological rejection, and endothelial decompensation. The appearance of folds or wrinkles that may develop in the graft was typically linked to worse-than-predicted vision. When the donor and recipient corneas' curvatures are not matched, there may occasionally be a significant curvature mismatch that results in wrinkles in the graft. Graft manipulation and centration might cause wrinkles. Furthermore, most of our patients have corneal transplants for BK rather than FECD, which is less common in Asia. In comparison to Fuchs' dystrophy, endothelial cell loss during DSAEK was higher in BK.[16,17]

Based on our results of testing donor origin cornea on the outcome, import donors provide a 1.8 times better outcome than local donors. This is because local donors still have 4 out of 9 patients with poorer outcomes, while all import donors, 8 out of 8 patients, have a good outcome. This is supported by Lekhanont et al. and Hsiao at al.. In some parts of the world, keratoplasty must be performed using imported donor corneas because of the difficulty in obtaining local donor tissue. DSAEK with imported donor corneas offers quick and effective vision recovery. The endothelial cell loss percentages utilizing domestic corneas were comparable to those seen in Western countries. The clinical results of DSAEK performed on precut donor corneas transported from abroad were also satisfactory. Also, endothelial cell loss during transportation did not seem to have an impact on the clinical results. Foreign eye banks' corneal donations can be beneficial, including lowering problems for patients in nations with insufficient donor corneal supplies.[18,19]

For the management of corneal endothelial dysfunctions, the EK offers a safe, effective, and quick substitute for conventional PK. The followings are different and most common complications of DSEK or DSAEK. One of the earliest complications after surgery is donor dislocation. Research believes that the incidences were between 0% - 82%, with an average of 14.5%.[20] In our study, no case of donor dislocation was recorded. Both complete dislocations into the anterior chamber and fluid at the interface of an otherwise well-positioned graft are possible causes of graft dislocation. Several factors can affect this, such as insufficient air bubbles to keep the graft steady, the presence of viscoelastic material or fluid

in the graft-host interface, the patient's inability to stay in a prone position and low IOP. Other factors might be because the eyes receive considerable pressure, such as trauma and eye rubbing. Finally, this may also be caused by poor endothelial cell function of the graft, grafts that are significantly larger than the recipient bed and accidentally flipped grafts.[21]

According to the published research, the occurrence of primary graft failure (PGF) was between 0% to 29%. Meanwhile, the average was 5%.[22] Other series reports interesting results since the failure rates of more experienced surgeons were from 0 to 3.5%. The Australian Corneal Graft Registry recorded 1214 endothelial keratoplasty patients. This study was acknowledged as the largest study in terms of the subject. The report showed that 140 out of 1214 patients experienced primary graft failure. PGF refers to grafts that have not resolved after two to three months. PGF has been connected to donor factors, like unhealthy tissue due to injury or storage time and unhealthy recipient circumstances because of blood or infection.

Furthermore, DSAEK complications can appear as a pupillary block by air. According to several datasets, pupillary block incidence ranges from 0.5% to 13%.[23] The overall frequency in our series was 5.9%. This is due to the displacement of bubbles that are too large. A primary pupillary block occurs when the air bubble in the front part of the eye is large enough to block the patient's pupil. This condition results in an iris bombé with an increase of intraocular pressure because air prevents the flow of water-like fluid from the back to the front parts of the eye. To prevent this problem, keeping a small amount of air in the front part of the eye and getting the pupil widened during surgery is often helpful. If a significant air bubble must be left in the anterior chamber to aid in graft adhesion, an inferior peripheral iridectomy can be necessary. To check if relatively significant air bubbles are still present in the eye after surgery, it is vital to observe the eye again about an hour following the procedure. Pupil dilatation and regurgitation of the paracentesis to remove part of the air are frequently necessary if the eye is discovered to be in a pupillary block. Ocular hypotensive drugs can also be used at the same time.[6,21]

Glaucoma after DSAEK is another compilation, having been reported to occur at a rate of 0 to 15%, with an average rate of 3%.[20] Elaify et al. reported 13.6% of cases. They believe causes of increased IOP after DSAEK include topical steroids, retained viscoelastic, inflammation, peripheral anterior synechiae, iatrogenic damage to the trabecular meshwork and distortion of the angle. Several factors contribute to IOP elevation.[24] In our study, glaucoma after DSAEK developed in one (5.9%) eye. A high frequency of IOP elevation reinforces the importance of regular IOP monitoring after DSAEK, as for all forms of corneal transplantation, especially in patients with established glaucoma.

The rejection rates of the grafts in the studies were between 0% to 45%. Meanwhile, the average rejection rate was 10%. The rate of graft rejection in the most recent and largest study involving 598 DSAEK eyes was 7.6 percent at 1 year and 12 percent at 2 years.[20] A graft rejection incident from earlier experiments led to graft failure, and they were successfully regrafted with DSAEK. In a previous study with participants under 50, Stulting et al. discovered that younger DSAEK patients were more resistant to their grafts. This might occur because older patients have a weaker immune system. The younger DSAEK patients may need more careful monitoring and consideration for longer-term topical corticosteroid therapy.[25] In our cases, the rejection rate was relatively lower (5.9%) since the average age was 58.17 years.

Infections following DSAEK surgery, whether in early post-operative or three months after, are usually dangerous. In this study, there was one case (5.9%) of iritis in 7 days after the operation. In addition, one eye (5.9%) was recorded to suffer conjunctivitis in 3 months, and one case (5.9%) experienced scleritis in 6 months with different patients. It was then accumulated to be a failed graft in 12 months follow-up. Early postoperative infections can be caused by contaminated donor tissue, improper removal of infected host corneas, or intake of environmental microbes. The infection typically appears within 1 to 2 days with ciliary injection, graft edema, mucopurulent discharge, and potential infiltration in the graft or near a suture. The infective focus was associated with a mid-peripheral vent incision. The vent incisions provide a conduit for deeper microbial penetration into the host stroma with a more aggressive clinical course. It is important to perform a gram stain and a culture with sensitivity. Before culture results are known, broad-spectrum topical antibiotics should be started. A graft should be replaced if it becomes seriously infected to avoid the onset of endophthalmitis.[20]

Several limitations should be acknowledged in this study. First, this study was an observational single-center retrospective study. It involved small samples of eyes studied; thus, there was no random treatment allocation. Also, the postoperative follow-up time was relatively short because many patients in this study were elderly and living far from our hospital. As a result, they might find it difficult to visit our hospital and get examined on a regular basis for a long time. Although this study has better clinical outcomes due to imported tissue, death to preservation time and preservation time to operative time should be compared. Post-operative endothelial cell counts may be another indicator to evaluate the graft condition. Thus, further studies that involve a larger size of patients are needed to increase the generalizability of the research. However, despite all the limitations, this study has significantly contributed to providing evidence of DSEK or DSAEK as a treatment for corneal dysfunction.

## CONCLUSION

In short-term results, DSEK or DSAEK surgery is safe, effective, and viable. We believe that it remains to be the most frequent EK surgery. Patients may also be informed that most EK surgery patients experience good visual results. More importantly, it is important to remind doctors and patients that patience is vital for EK surgery because the vision will improve with time. Further large-scale analytic study is needed to enhance the applicability of the research findings.

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## ETHICAL CLEARANCE

The ethical review has been submitted to the Health Research Ethic Committee, Ibnu Sina Regional Public Hospital, with approval number 071/007/437.76/2023.

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None.

## CONFLICT OF INTERESTS

The author reports no conflicts of interest in this work.

## AUTHORS' CONTRIBUTION

The preparation, data collection, analysis, writing, and approval of this paper for publication were all done by all authors equally.

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