



## Original Research Article

## Outcomes of Descemet's stripping endothelial keratoplasty in patients with secondary glaucoma

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## ABSTRACT

**Introduction:** Aim of the study is to analyse the outcomes of Descemet's stripping endothelial keratoplasty (DSEK) for corneal oedema in patients with secondary glaucoma. Our's is retrospective review of the outcomes of DSEK that was performed for corneal decompensation in patients with secondary glaucoma.

**Materials and Methods:** A total of 93 patients, of which 17 had been diagnosed with secondary glaucoma, were included in the study. All patients underwent medical or surgical treatment to control intraocular pressure (IOP) before DSEK. The clinical outcomes of DSEK in these patients were evaluated. The data collected included demographic patterns, indications, medical or surgical treatment for glaucoma, intra-operative and post-operative complications of DSEK, IOP changes before and after DSEK, and post-operative visual outcomes. The data were analysed based on the different aetiologies of secondary glaucoma such as iridocorneal endothelial (ICE) syndrome, pseudoexfoliation (PXF) syndrome, glaucoma in pseudophakia, traumatic glaucoma, and inflammatory glaucoma. The average IOP of each patient was calculated using both applanation tonometry and Tono-pen before and after DSEK and at every follow-up. Main Outcome Measures

Graft clarity, IOP changes, and visual outcomes after DSEK were evaluated for all patients.

**Results:** DSEK was performed for the following causes of secondary glaucoma in descending order: PXF, 6 patients; ICE, 4 patients; glaucoma in pseudophakia, 3 patients; traumatic glaucoma, 2 patients; and inflammatory glaucoma, 2 patients. Two patients underwent trabeculectomy, 5 patients underwent aqueous tube drainage surgery, and 13 patients were administered medication before DSEK. At the 1-year follow-up, 14 patients had clear grafts with best corrected visual acuity (BCVA) scores greater than 6/36, while the BCVA scores of the other 3 patients were below 6/60.

**Conclusion:** DSEK is an appropriate method for treating all types of secondary glaucoma. After DSEK, the visual recovery, refractive outcomes are superior and the rise in IOP is minimal compared to those after Full thickness Keratoplasty, since the angle anatomy and corneal contour is maintained.

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### 1. Introduction

Endothelial keratoplasty has recently emerged as the procedure of choice for managing purely endothelial pathologies, with most surgeons favouring its numerous advantages over penetrating keratoplasty.<sup>1</sup> Secondary glaucoma includes conditions in which elevated IOP and optic disc changes are consequences of a primary ocular or systemic disease. It

can be further classified as secondary open-angle glaucoma and secondary angle-closure glaucoma. Several studies have described the benefits, post-operative complications, and visual outcomes of DSEK in patients who have previously undergone surgery for glaucoma. However, few reports have taken into consideration the different aetiologies of secondary glaucoma and the outcomes of using DSEK to treat endothelial failure. Anshu *et al.* reported lower graft survival after DSEK in eyes that had previously undergone trabeculectomy/tube shunt

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implantation.<sup>2</sup> Similarly, Dacroos *et al.* reported an increased incidence of graft failure in eyes with tube shunt implantation,<sup>3</sup> but not in eyes that had undergone trabeculectomy.<sup>3,4</sup>

## 2. Materials and Methods

We performed a retrospective analysis of the glaucoma case records of 93 eyes of 93 patients who underwent DSEK performed by a single surgeon between January 2014 and July 2017 at a tertiary eye care centre with informed consent. The institutional review board/ethics committee ruled that approval was not required for this study. The study was conducted in accordance with the recommendations of the Declaration of Helsinki (2013 revision).<sup>5</sup> Seventeen eyes with secondary glaucoma were included in our study with a follow-up period longer than 1 year after DSEK. We divided the patients into 2 groups depending on whether their IOP had been treated with surgery or with medication before DSEK. The medical group included patients receiving either single or dual topical medications depending on the extent of IOP control. The surgical group included patients who had undergone implantation of an Aurolab aqueous drainage implant (AADI) or trabeculectomy with 0.04% mitomycin C after failure of pharmacotherapy. DSEK was performed to treat corneal oedema in all patients. We collected data related to the demographic patterns, indications, medical or surgical treatments for glaucoma, intra-operative and post-operative complications of DSEK, IOP changes before and after DSEK, and post-operative visual outcomes. We analysed these data based on the various aetiologies of secondary glaucoma included in our study, i.e. iridocorneal endothelial (ICE) syndrome, pseudoexfoliation (PXF) syndrome, glaucoma in pseudophakia, traumatic glaucoma, and inflammatory glaucoma. We calculated the average IOP for each patient before and after DSEK and at every follow-up with applanation tonometry and Tono-pen. IOP greater than 21 mmHg was considered elevated, in accordance with the European Glaucoma Society terminology and guidelines for glaucoma.<sup>6</sup> All data were compiled using Microsoft Excel for subsequent analysis.

### 2.1. Statistical analysis

The medians of continuous variables with skewed distribution between the 2 groups (medical versus surgical) were compared using the Wilcoxon signed-rank test. We considered  $p$  values  $<0.05$  to be statistically significant.

### 2.2. Surgical technique

We manually dissected and prepared donor grafts to the desired thickness of 190  $\mu\text{m}$  using Katena's Artificial Anterior Chamber with a 350  $\mu\text{m}$  guarded crescent blade. Donor corneas with an endothelial count higher than

2500 cells per  $\text{mm}^3$  were preferred. Temporal small incision cataract surgery (SICS) was performed if the recipient's eye had a superior bleb. Superior SICS or clear corneal phacoemulsification was performed in cases with inferior AADI. The procedure included peripheral anterior synechiae release, Descemet's membrane rhexis, peripheral iridectomy, automated vitrectomy, synechiolysis, and cataract extraction, and replacement with an intraocular lens (IOL) or iris claw IOL exchange with tube revision in required cases was performed.

After surgery, patients received a dose of eye drop 1% prednisolone acetate 6 times over 2 weeks, which was tapered to 5 times over 2 weeks, and subsequently tapered to 4,3,2 and 1 administrations over the following 4 months respectively. Patients also received a prophylactic antibiotic in a tapered dose of E/D 0.3% gatifloxacin 6 times over 1 week, followed by 4 times over another week. E/D homatropine hydrobromide twice a day along with anti-glaucoma medication was also added for 2 weeks.

## 3. Results

A total of 17 eyes of 17 patients were included in our study, and the median age was 60.7 years (range, 38 – 80 years); 58.8% of the patients were men and 41.8% were women. The mean follow-up duration after diagnosis of glaucoma was 5.4 years (range, 1 – 14 years). The mean duration of follow-up after DSEK was 1.4 years (range, 1 – 4 years). The indications for DSEK were endothelial failure as a result of ICE syndrome in 4 eyes (Figure 1) PXF syndrome in 6 eyes, glaucoma in pseudophakia in 3 eyes, traumatic glaucoma in 2 eyes, and inflammatory glaucoma in 2 eyes. There was no significant difference in the mean age/sex distribution between the medical and surgical groups.

We used a Wilcoxon signed-rank test to compare the patient's IOP before and after DSEK, which revealed no significant difference ( $p=0.093$ ). The median IOP was 20 mmHg before DSEK (range, 11 – 34 mmHg) and 14 mmHg after DSEK (range, 10 – 30 mmHg). Table 1 summarises the IOP observed before and after DSEK. The mean BCVA score before DSEK was 1.08 (range, 1.00 – 2.6) logMAR and 0.48 (range, 0.18 – 2.6) logMAR after DSEK. Table 2 depicts the visual outcomes and follow-up after DSEK. In Table 3, the Wilcoxon signed-rank test revealed a statistically significant difference between the best corrected visual acuity (BCVA) of the patients before (1.08) and after DSEK (0.48) ( $p=0.001$ ).

The medical group consisted of 10 patients. The surgical group consisted of 7 patients, of which 5 had undergone AADI and 2 had undergone trabeculectomy before DSEK. The within-group differences in median IOP before and after DSEK were not significant for either group (Table 1). Conversely, the within – group differences in median visual acuity before and after DSEK were significant for both groups (Table 2). The graft failure rate was high in the

surgical group (42%) compared to that in the medical group. Medical group had no graft failures.

Only one patient with inflammatory glaucoma exhibited persistent post-operative rise in IOP. AADI surgery was performed to stabilise the rising IOP, and the graft clarity was subsequently maintained during the 3-year follow-up period. The patient showed a good Snellen visual acuity score of 6/18. All other patients showed good IOP control after DSEK.

In the medical group, DSEK combined with cataract extraction and posterior chamber IOL was performed for 2 eyes, and DSEK combined with iris claw IOL exchange was performed for 4 eyes. Most of the eyes that underwent DSEK were pseudophakic (64.7%). Tube revision was performed for 2 eyes. Synechiolysis, synechiae release, pupiloplasty, and multiple iridotomies were performed due to disorganised anterior chamber structures in the eyes of all patients.

Graft failure was defined as persistent corneal oedema resulting in a permanent loss of optical clarity. Primary graft failure and pupillary block occurred postoperatively in 1 eye each in 2 patients, 1 with glaucoma in pseudophakia and the other with PXF glaucoma. Two showed graft rejection 1 year after DSEK, 1 of whom had traumatic glaucoma and the other had glaucoma in pseudophakia. One case of graft detachment was noted immediately during the post-operative period in a patient with PXF glaucoma. Rebubbling was performed, and the graft clarity was subsequently maintained up to a mean follow-up duration of 3 years. One patient with inflammatory glaucoma developed post-DSEK glaucoma. An AADI was placed in order to control the patient's IOP.

In the 2 patients with traumatic glaucoma, DSEK was successful irrespective of whether the patients had previously undergone glaucoma surgery. Both patients had good BCVA scores, although 1 patient who had previously undergone trabeculectomy experienced an episode of graft rejection but recovered completely.

Among the 4 patients with ICE syndrome, IOP was controlled via the implantation of AADI in 2 patients and with medications in the remaining 2. Good results regarding graft clarity and IOP control were recorded in both groups over a 1-year period. Figure 1 shows the images of the patients with ICE syndrome before and after DSEK, with clear corneas and gratifying results. Graft failure due to poor IOP control following DSEK occurred in the 3 patients diagnosed with pseudophakia.

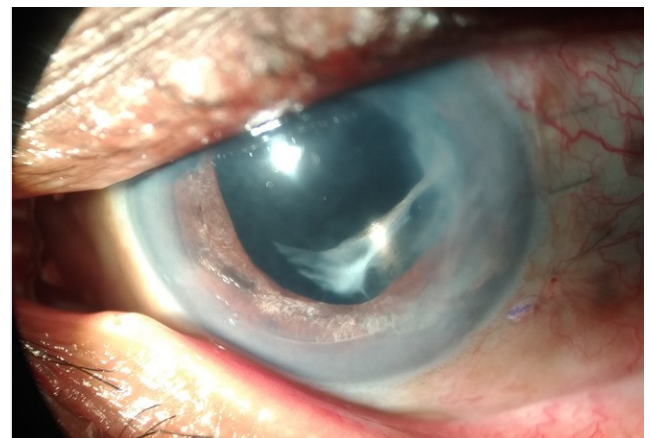
The IOP of all 6 patients with PXF glaucoma was successfully controlled with medications before DSEK, and we observed 100% graft clarity over the 3-year follow-up period.

Inflammatory glaucoma is a secondary glaucoma that often combines components of the open-angle and closed-angle conditions. One patient with secondary open-angle

glaucoma who underwent AADI surgery before DSEK was maintained on a single anti-glaucoma medication. He showed a good Snellen chart, with a BCVA score of 6/12 at the 3-year follow-up. One patient with secondary angle-closure glaucoma, who was on maximum medication for the treatment of elevated IOP before DSEK, developed post-operative persistent rise in IOP for more than 3 months, AADI surgery was performed after DSEK to control IOP. This persistent rise in IOP might be attributed to inflammation or steroid use. The graft remained clear during the 3-year follow-up.



**Fig. 1:** Pre OP



**Fig. 2:** Post OP

#### 4. Discussion

Penetrating keratoplasty has been the standard treatment for patients with corneal oedema due to endothelial failure.

**Table 1:** Comparison of IOP before and after DSEK

Variable	Median	Minimum	Maximum	P-value
IOP before DSEK	20	11	34	0.14
IOP after DSEK	16	16	30	

**Table 2:** Comparison of VA before and after DSEK

VA in LogMAR	Median	Minimum	Maximum	P-value
VA before DSEK	1.08	1	3	0.008
VA after DSEK	0.48	0.18	2.6	

DSEK:Descemet's stripping endothelial keratoplasty, VA: visual acuity

**Table 3:** Comparison of IOP and VA between groups

Variables		Before DSEK	After DSEK	P value
IOP	Medical group	14	15	0.19
	Surgical group	22	12	0.31
BCVA	Medical group	1.08	0.48	0.008
	Surgical group	1.08	0.48	0.04

BCVA: best corrected visual acuity, IOP: intraocular pressure.

However, it has several drawbacks, including a prolonged time for visual recovery, ocular surface problems, high risk of graft failure due to glaucoma, and complications resulting from sutures. DSEK is emerging as a better alternative for treating endothelial dysfunction. Nevertheless, in patients with glaucoma drainage devices,<sup>7</sup> this procedure is more challenging due to the need for drainage tube revision sphincterotomy and lysis of adhesions that are crucial for the enhancement of the anterior chamber space and allow for good Descemet's stripping, graft positioning, and bubble distribution. Several reports in the literature have documented the outcomes of DSEK in eyes with glaucoma drainage tubes. However, our study takes into account the various aetiologies and prognosis of secondary glaucoma in addition to glaucoma drainage devices, the effects of IOP changes on graft survival, and the visual outcomes after manual DSEK performed by the same surgeon.

Our study observed no significant change in IOP before and after DSEK. Kim *et al.* previously reported similar findings, although their study included 1 patient who did exhibit significant changes due to the primary pathology. In 2014, Aldave *et al.*<sup>1</sup> reported elevation in IOP following DSEK in patients with previous trabeculectomy /drainage tubes for glaucoma. This was observed more frequently in the medically-treated eyes (41.4%) than in the surgically-treated eyes (23.8 %). Although the rise in IOP was statistically insignificant, we observed elevation in IOP more often in the surgical group, most probably due to chronic steroid use and other intra-operative manipulations that are performed for secondary glaucoma and secondary inflammations. An uncontrolled rise in IOP occurred postoperatively in one patient with inflammatory glaucoma due to inflammation and chronic steroid use and required AADI placement in order to control the IOP.

The immediate post-operative complications observed in our study were pupillary block due to air (5.8%) and graft dislocation (5.8%), which required air bubble release and rebubbling, respectively, both sequelae occurred in the medical group, in contrast to several earlier studies<sup>3,5,6,8</sup> that have reported a higher incidence of complications in patients with DSEK following glaucoma drainage device insertion. This could be attributed to the disorganised anterior chamber in patients with secondary glaucoma.

We also noted a higher incidence of primary graft failure in the surgical group (12.5%) in our case series, similar to the findings of Aldave *et al.*(4.4%)<sup>1</sup> and Wiaux *et al.*(5.4%).<sup>6</sup> Secondary graft failure resulting from graft rejection and late endothelial failure occurred in 2 patients in our study (11.7%) compared to 15.9% in the study by Aldave *et al.* Alvarenga *et al.* and Pederson *et al.*<sup>9</sup> reported glaucoma drainage devices as the independent risk factor for graft failure. In our study, in addition to history of tube surgery, a previous diagnosis such as glaucoma in pseudophakia was identified as the highest risk factor (17%) for graft survival compared to PXF glaucoma, ICE syndrome, and trauma.

Similar to the studies performed by Aldave *et al.*<sup>1</sup> Kim *et al.*<sup>10</sup> Vajaranant *et al.*, and Wiaux *et al.*<sup>6</sup> our comparison of corrected distance visual acuity before and after DSEK (Table 2) revealed a statistically significant difference ( $p < 0.05$ ), probably because DSEK does not alter the corneal shape and does not cause astigmatism due to sutures compared to penetrating keratoplasty.

We analysed the graft clarity, visual outcomes, and IOP changes based on various aetiologies of secondary glaucoma in patients following the DSEK procedure. We observed good outcomes in patients with PXF syndrome, ICE syndrome, and open-angle inflammatory glaucoma, but

patients with traumatic glaucoma, pseudophakia, and angle-closure inflammatory glaucoma exhibited poor outcomes. Tube shunts are a more effective method of controlling IOP in patients with various angle structure anomalies compared to filtering procedures as reported by earlier studies by Kim *et al.*<sup>10</sup> and Quek *et al.*<sup>11</sup>

The greatest limitation of our study is its retrospective design. Therefore, we were unable to consider associated endothelial loss and visual field and optic disc changes in our assessment of glaucoma progression. Our study would also benefit from long-term follow-up. Earlier studies analysed the outcomes of DSEK in patients with pre-existing glaucoma drainage tubes and those who had undergone filtering surgeries. To the best of our knowledge, this study is one of the few to have analysed IOP changes, visual outcomes, and complications associated with the wide aetiologies of secondary glaucoma following DSEK.

## 5. Conclusion

The low incidence of intra-operative complications in our case series proves that the presence of tube shunts does not affect the DSEK procedure. To our surprise, we discovered excellent prognosis when DSEK was performed in patients with ICE syndrome and in those with iris claw IOL exchange. Hence, we conclude that DSEK has an excellent prognosis in these complicated cases, but careful post-operative IOP monitoring is essential to ensure compliance with the treatment plan, with follow-up to ensure long-term survival of the grafts in these patients.

### 5.1. Abbreviations

AADI: Aurolab aqueous drainage implant  
 BCVA: best corrected visual acuity  
 DSEK: Descemet's stripping endothelial keratoplasty  
 ICE: Iridocorneal endothelial syndrome  
 IOL: Intraocular lens  
 IOP: Intraocular pressure  
 PCIOL: Posterior chamber intraocular lens  
 PXF: pseudoexfoliation  
 SICS: Small incision cataract surgery

## 6. Acknowledgement

None.

## 7. Conflicts of interest

None.

## 8. Source of Funding

None.

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