

# Descemet stripping automated endothelial keratoplasty in phakic eyes: incision modification reducing cataract formation

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## Abstract

• **AIM:** To evaluate the efficacy of a technical modification to reduce the incidence of traumatic cataract induced by Descemet stripping automated endothelial keratoplasty (DSAEK) performed in phakic eyes.

• **METHODS:** A retrospective cohort study. The records of all patients with a clear crystalline lens and endothelial failure that underwent modified DSAEK at our institution were reviewed. In this modification, in order to avoid inadvertent touch of the insertion forceps against the exposed crystalline lens while passing across the anterior chamber, the incision sites were shifted from the standard 9 and 3 o'clock positions, superiorly to the 10 and 2 o'clock position respectively. Formation of typically traumatic, anterior subcapsular cataract in these patients was compared to that observed in a cohort including all the patients with a clear crystalline lens and endothelial failure that underwent conventional DSAEK at our institution.

• **RESULTS:** The study group included 49 eyes following modified DSAEK and the control group included 35 eyes

following DSAEK with conventional incision sites. Anterior subcapsular cataract occurring 4mo or less postoperatively was identified in 2 of 49 (4%) eyes in the study group and 7 of 35 (20%) eyes in the control group. The rates of traumatic cataract were significantly higher in the control group in comparison to the study group ( $P=0.03$ ,  $RR=4.9$ ,  $95\%CI 1.08-22.1$ ).

• **CONCLUSION:** Traumatic cataract formation following phakic DSAEK may be avoided with a simple modification to the position of the incision sites.

• **KEYWORDS:** cornea; Descemet stripping automated endothelial keratoplasty; cataract; lamellar keratoplasty

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## INTRODUCTION

Descemet stripping automated endothelial keratoplasty (DSAEK) has been established as the most common treatment for patients with endothelial failure<sup>[1-2]</sup>. Increasing and reproducible success has resulted in surgery being performed earlier in the course of endothelial disease<sup>[3]</sup>. As a result, appropriate management of phakic patients, especially those of a younger age, has become an important issue, particularly in relation to whether or not to combine lens surgery with the endothelial transplantation<sup>[4]</sup>.

Cataract formation after penetrating keratoplasty (PK) occurs mainly secondary to surgical trauma (anterior subcapsular cataract) or as a side effect of corticosteroid use (posterior subcapsular or nuclear sclerotic cataract)<sup>[5-6]</sup>. Following endothelial keratoplasty (EK), the etiology could be expected to be the same, although surgical trauma may play a greater role due to surgical manipulations within the confined space of the anterior chamber. Indeed, a recent study reported anterior subcapsular cataracts to account for 81% of cataract extractions after Descemet membrane endothelial keratoplasty<sup>[7]</sup>. There is limited information regarding the outcomes of DSAEK without lens extraction in phakic patients, and the rate of

cataract formation reported ranges from 7% to 43%<sup>[8]</sup>. The cataract formation and extraction rate following earlier posterior lamellar keratoplasty techniques was even higher, with that following deep lamellar endothelial keratoplasty being reported at 80% to 100%<sup>[9-10]</sup>.

In an attempt at reducing the rate of traumatic cataract formation in phakic eyes undergoing DSAEK, we have previously introduced a simple modification to our standard temporal-nasal approach, by shifting the incision sites superiorly by 1h<sup>[11]</sup>. In this study we have evaluated the outcomes of this modified procedure in comparison with those of our standard technique<sup>[12]</sup>.

**SUBJECTS AND METHODS**

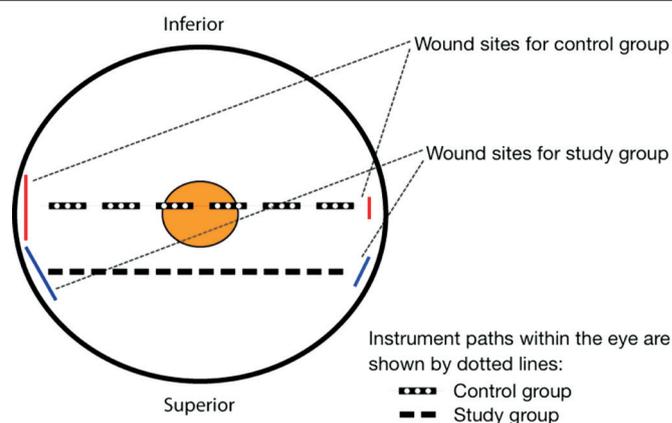
This retrospective cohort study followed the tenets of the 2013 Declaration of Helsinki and was approved by the local ethics committee (Comitato Etico Ospedali Privati Villa Serena-Villa Igea). Medical records of all phakic eyes that had undergone DSAEK without lens surgery at our institution from January 2007 to October 2014 were reviewed. Inclusion criteria were corneal endothelial failure treated with DSAEK, and retainment of the natural crystalline lens during the procedure. Exclusion criteria were preoperative lens opacities of any degree and any other surgery combined with DSAEK. All surgeries were performed by a single surgeon (Busin M). Recordings of the surgery were evaluated to confirm surgical wound position and patients were divided into two groups; the study group included all eyes with incisions shifted to the 10 and 2 o'clock position, while the control group included all those with the original wound placement, at 9 and 3 o'clock.

All patients had undergone a detailed ophthalmic examination prior to surgery including uncorrected visual acuity (UCVA), best-corrected visual acuity (BCVA), slit lamp biomicroscopy, clinical photography, applanation tonometry, and funduscopy. Written informed consent was obtained in all patients before surgery. None of the participants received a stipend.

After surgery, all patients had been examined at day one and week one, with further examinations at 1, 3, 6, 12mo and every year thereafter, when possible. Postoperative measurements, commencing at month one, had included UCVA, BCVA, slit lamp biomicroscopy, applanation tonometry, and endothelial cell count (Tomey EM-3000, Nagoya, Japan), or examination under anesthesia when indicated in the case of the infants.

Anterior subcapsular cataracts identified 4mo or less postoperatively were considered traumatic whereas nuclear, cortical or posterior subcapsular cataract appearing later were considered to be non-traumatic.

**Surgical Technique** Surgery was performed under peribulbar local anesthesia (levobupivacaine 75 mg/10 mL) in all adult patients. Children and infants were operated on under general anesthesia.



**Figure 1 Wound site modification in phakic DSAEK** Schematic representation showing wound placement for modified DSAEK in phakic eyes. Conventional wound locations for DSAEK used for the control eyes are also illustrated for comparison.

Our standard, previously published technique was employed in all cases<sup>[10]</sup>. Briefly, after removing the endothelium from the recipient central cornea, a DSAEK graft was loaded and folded into the Busin glide (Moria, Antony, France). Under continuous infusion from an anterior chamber maintainer, the Busin forceps (Moria, Antony, France) was inserted through a temporal side entry and passed across the anterior chamber, exiting through a nasal clear cornea tunnel to grab the graft from the Busin glide and drag it into the anterior chamber. For the eyes in the study group both the nasal 3.2 mm clear corneal incision, and the temporal 1 mm clear corneal incision were shifted approximately 1 mm superiorly from their usual 9 and 3 o'clock positions, that had been used for all control eyes (Figure 1).

In addition, in both groups, the inferior peripheral iridotomy had been performed as far peripherally as possible, to avoid possible tamponade by the crystalline lens from behind, and consequent pupillary block in the early postoperative period.

The patients were examined at 2h postoperatively (at the slit lamp for adults, and under the operating microscope for infants) and, if the air level was not above the inferior iridotomy in the sitting position, indicating a risk of pupillary block, some air was removed from the anterior chamber.

Postoperative management did not differ in the two groups, and included topical tobramycin sulfate, 0.3% and dexamethasone phosphate 0.1% two-hourly for 14d, and then tapered over 3-4mo to a single daily administration, before being discontinued at 6-8mo. All sutures were removed 4-6wk postoperatively in adults, but as early as 1wk after surgery in infants.

As this study was focused on surgically induced cataract, data about postoperative visual acuity, endothelial cell count, graft survival and other outcome parameters were not analysed.

**Table 1** Descemet stripping automated endothelial keratoplasty done with standard incisions vs modified incision sites in phakic eyes

Parameters	Standard incision sites	Modified incision sites	P	Relative risk
No. of eyes	35	49		
Age (a, mean±SD)	44.8±16.1	35.7±20.8	0.033	
Follow-up (mo, mean±SD)	25.9±11.3	13.8±9.6	<0.0001	
Postop. cataract-any type	11 (31%)	5 (10%)	0.0229	3.08 (95%CI 1.17-8.07)
Traumatic cataract	7 (20%)	2 (4%)	0.0304	4.9 (95%CI 1.08-22.1)
Steroid induced cataract	2 (6%)	2 (4%)	1	
Senile cataract	2 (6%)	1 (2%)	0.56	

**Statistical Analysis** All data collected in the study were entered into an electronic database (Microsoft Excel 2007). Data were analyzed with the MedCalc online calculators (MedCalc Software, Mariakerke, Belgium). For the analysis of quantitative measures we used two-tailed Student's *t*-test. Fishers' exact test was used for the analysis of categorical variables. Whenever appropriate, relative risk ratios (RR) were calculated. Differences were considered statistically significant when the *P*-value was less than 0.05.

## RESULTS

### Study Population and Early Postoperative Complications

Patient characteristics, intraoperative and postoperative results are summarized in Table 1. Eighty-four eyes of 74 patients with clear lens and endothelial failure, that had undergone DSAEK at our institution were identified. Forty-nine eyes (58%) underwent DSAEK using the superiorly placed incision sites (study group). Thirty-five eyes (42%) underwent DSAEK using the conventional incision sites. Age and follow-up times differed between the groups: mean age was 35.7±20.8y in the study group and 44.8±16.1 in the control group (*P*=0.033). Follow-up time averaged 13.8±9.6mo for the study group and 25.9±11.3mo for the control group (*P*<0.0001). Preoperative slit lamp examination revealed clear crystalline lens in all cases.

DSAEK was performed without complication in all cases. Five cases (4 infantile eyes and 1 adult eye) required re-injection of air due to graft dislocation, occurring within 2d after surgery (1 eye in the study group, 4 eyes in the control group; *P*=0.15). Following re-bubbling, the donor tissue was successfully attached in all cases. All corneas were clear by 1wk after successful attachment. There were no cases of pupillary block or primary graft failure in this series.

**Postoperative Cataract Formation** Sixteen eyes (19%) developed lenticular opacity during the study period. In the study group, cataract formation was seen in 5 eyes (10%): 2 of these (4%) were of the anterior subcapsular type and occurred in the initial 4mo after surgery while 3 were seen later than 12mo and affected mainly the nucleus and the posterior subcapsular layers of the lens. In the control group, 11 eyes

(31%) developed cataract. Seven (20%) were of the anterior subcapsular type and 4 of the nuclear or posterior subcapsular type. The rates of traumatic cataract differed significantly between the study group and the control group (*P*=0.0304, RR=4.9, 95%CI 1.08-22.1). All but 1 of these patients underwent successful phacoemulsification with in the bag implantation of a monofocal intraocular lens (IOL) early after diagnosis. The remaining patient chose not to have cataract surgery due to the presence of amblyopia as well as personal preference.

## DISCUSSION

Our initial results, prior to performing surgery with the new incision sites, supported the findings of other authors, in that the rate of cataract formation post-DSAEK exceeded the rate expected in the normal population, and affected mostly the older age group<sup>[9,13]</sup>.

After analysing our initial results, we believed that modifying the technique of DSAEK in phakic eyes, could improve the safety profile for this surgery. The most obvious way to try to protect the crystalline lens during surgery would be to constrict the pupil. However, it is our opinion that a pharmacologically constricted pupil would be at increased risk of iris sphincter rupture if pupillary block develops, as may be more often the case in phakic patients whose crystalline lens could more easily block an inferior iridotomy that is not peripheral enough. For this reason, in phakic eyes, we prefer a dynamic pupil and do not employ pharmacological constriction. In addition, although in most cases of this series the peribulbar anesthesia induced some degree of mydriasis, we observed that the pupil constricted spontaneously during the endothelial removal steps performed under air, effectively reversing the mydriasis without any pharmacological intervention.

Intraocular manipulation during graft delivery is the issue that should be addressed next in an attempt at reducing the risk of cataract formation in phakic eyes undergoing DSAEK. A variety of tissue insertion techniques have been employed with success by DSAEK surgeons. Koenig<sup>[14]</sup> and Price *et al*<sup>[8]</sup> have both reported success with forceps insertion in the phakic eye, with relatively low rates of cataract formation. We had similar

results in terms of cataract formation rates using the glide assisted “pull-through” technique, but these rates of cataract formation are still higher than ideal rates<sup>[12]</sup>. The main problem encountered during surgery on our initial cohort of patients was that passing across the anterior chamber with the forceps and grasping the tissue sometimes resulted in shallowing of the anterior chamber, and contact between the forceps and the lens. This problem was exacerbated when small, hyperopic eyes with shallow anterior chambers and positive vitreous pressures were operated on.

By moving the wounds for graft insertion superiorly, we prevented the the instruments to pass across the pupillary level. As a consequence, should the anterior chamber collapse, not only would the iris prevent direct contact between lens and instruments, but also any possible trauma would be peripheral. The anterior chamber maintainer created enough space in the anterior chamber to perform the surgery safely in all of the eyes in this study, particularly as these non-cataractous eyes had relatively little lenticular bulk.

Modifying the wound position resulted in a significant reduction of traumatic cataract formation. The fact that 2 cases (4%) did develop cataract shows that the risk does still exist, however, this reduced rate is certainly more acceptable. Different rates of non-traumatic cataract formation between the groups may have resulted from the difference between the groups in age and follow-up time.

Of all published reports, only one by Price *et al*<sup>[8]</sup> addresses possible factors causing cataract after DSAEK in phakic eyes. In this report the overall cataract formation rate was 43%. The cataract was of the posterior subcapsular type in 17% of eyes and of the anterior subcapsular type in 10%. When they excluded from their analysis patients older than 50 years of age, the probability of cataract extraction was 0 at 1y, and 7% at 3y. Probabilities were much higher for older patients (31% and 55%), identifying age greater than 50 as a significant risk factor for cataract formation after phakic DSAEK<sup>[8]</sup>.

In a series by Tsui *et al*<sup>[15]</sup>, 3 of the 4 eyes that developed cataract had experienced pupillary block in the early postoperative period, suggesting this as a possible causative factor. Pupillary block after EK can be prevented by careful management of the air bubble in the immediate postoperative period<sup>[16]</sup>. With our air management strategy, no case of pupillary block occurred, but 9 eyes developed traumatic cataract anyway.

In eyes with visually significant lens opacity and corneal endothelial failure, cataract extraction and insertion of IOL is often performed, either before EK or at the time of EK<sup>[3]</sup>. Lens extraction with IOL implantation may be justified in older patients without accommodative function, even in the presence of a clear crystalline lens, either before or concurrently with EK. We currently perform cataract surgery at the time of

DSAEK for any patient above the age of 50 regardless of the lens status. Also for younger, phakic patients with good accommodative function, most surgeons initially preferred to remove the clear crystalline lens<sup>[3,17]</sup>. Reasons for this approach included the risk of iatrogenic cataract formation, and increased difficulty of the DSAEK surgery in phakic eyes<sup>[14]</sup>. However, iatrogenically induced early presbyopia is undesirable, and more surgeons now are choosing to perform EK leaving the eyes phakic. Furthermore, recent evidence suggests that eyes left phakic enjoy visual results that exceed those of eyes undergoing combined EK and IOL surgery, with the majority of patients achieving a visual acuity of 20/20 or better<sup>[7,18-19]</sup>. Finally, the decision not to remove a clear lens at the time of EK is supported by the evidence that cataract surgery can be safely performed as a secondary procedure in eyes that eventually develop significant cataract after EK<sup>[7-8,19-20]</sup>.

Limitations of our study include the retrospective design and the differences between groups in age and follow-up. However, only anterior subcapsular cataracts were considered in the comparison between the 2 groups: this type of cataract is of traumatic origin and not age-related; it also occurs early in the postoperative period, thus eliminating the effect of age and follow-up in our study.

In conclusion, our data supports the use of a slightly superior wound placement for DSAEK in phakic eyes, which reduces the risk of traumatic cataract formation and diminishes the need for performing unnecessary clear lens extraction in pre-presbyopic eyes with endothelial failure.

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