

Outcomes of Penetrating Keratoplasty and Deep Anterior Lamellar Keratoplasty for Keratoconus in a University Teaching Hospital

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Abstract

Purpose: To compare outcomes of penetrating keratoplasty (PK) and deep anterior lamellar keratoplasty (DALK) in keratoconic eyes in a university teaching hospital setting

Methods: In this longitudinal cross-sectional study all patients who underwent PK or DALK for keratoconus at 2 years period were included to the study. The patients were recalled and complete eye examination including best spectacle corrected visual acuity (BSCVA), refraction, topography and contrast sensitivity were accomplished and the results were compared in the two groups.

Results: A total of 106 patients underwent PK or DALK for keratoconus which were included in our study, of them 57 eyes underwent PK and 49 eyes underwent DALK. Mean follow-up time in PK and DALK groups were 35.0 ± 2.4 and 30.3 ± 2.5 Mo respectively ($P=0.17$). The mean postoperative BSCVA in DALK group was 0.28 ± 0.04 logMAR and in PK group was 0.28 ± 0.03 logMAR ($P=0.99$). The postoperative mean SE in PK and DALK groups were -2.74 ± 0.58 diopter (D) and -3.46 ± 0.52 D, respectively ($P=0.36$). Mean topographic Astigmatism in PK group was 3.81 ± 0.28 and in DALK group was 4.21 ± 0.42 ($P=0.42$). The contrast sensitivity functions (CSFs) in all spatial frequencies in DALK group was significantly lower than PK group. One graft in PK group and four grafts in DALK group were failed during follow-up time.

Conclusion: Visual and refractive outcomes in PK and DALK for keratoconus are comparable. Whereas CSFs were lower in DALK in comparison to PK and graft failure was higher in DALK.

Keywords: Penetrating Keratoplasty, Deep Anterior Lamellar Keratoplasty, Contrast Sensitivity Functions, Graft Failure

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Introduction

Keratoconus (KCN) is the leading cause of keratoplasty in Iran.¹ Penetrating keratoplasty (PK) has been an established treatment for KCN over the past years. Results of PK in KCN are extremely fabulous.² But outcome can be complicated with endothelial graft rejection. Graft rejection occurs in one forth of patients, most of them are endothelial rejections.^{2,3} Endothelial rejection and chronic endothelial cell loss is the commonest cause of graft failure.^{4,5} Deep anterior lamellar keratoplasty (DALK) has been described as a successful treatment in KCN.^{6,7} It replaces abnormal cornea while preserving the patient's endothelium thereby eliminates endothelial graft rejection and complications of intraocular surgery but it has some disadvantage including longer learning curve and longer operation time⁸ the presence of interface that potentially may scatter light and reduce quality of vision.⁶

Although several studies reported no significant differences in visual outcome of the PK and DALK⁹⁻¹¹ several others demonstrated less favorable contrast sensitivity^{12,13} and high overall graft failure in DALK.¹⁴

In this study we investigate visual outcomes including contrast sensitivity in two groups of keratoconic patients who underwent PK and DALK in a university teaching hospital.

Methods

This longitudinal cross-sectional study includes all patients who had undergone primary PK or DALK for KCN in Nikookari Eye Hospital in Tabriz, IRAN between June 2008 to April 2010. Medical records were reviewed for demographic data and surgical technique. Local committee of ethics approved the study design. All patients were recalled for eye examination including best spectacle corrected visual acuity (BSCVA), refractive and topographic astigmatism and contrast sensitivity. In DALK group just the cases with exposed intraoperative descemet's membrane (DM) (according to surgeon's operation note) were entered to study.

All patients had been operated by 3 surgeons all of them were undertaking learning curve for DALK procedure. For this procedure Big Bubble technique described by Anwar was used. The size of trephination was

based on vertical corneal diameter and was between 7.50 to 8.25 mm and Donor-Recipient disparity was 0.25 mm in all cases. All eyes received subconjunctival antibiotic and corticosteroid at the end of operation. Postoperative treatment includes topical antibiotic, corticosteroid and artificial tear eye drops. Patients with at least 12 months follow-up and after removal all sutures were entered to study.

Visual acuity (VA) was measured by standard Snellen 6 meter chart and was converted to log Mar equivalent unit.

A Placido based corneal topography (eye sys) was used to measure postoperative topographic astigmatism. We used contrast sensitivity chart CSV 1000 to measure contrast sensitivity functions (CSFs) and test was performed in 3, 6, 12 and 18 cycle per degree. The test was done for a distance of 8 feet (2.5 m) under the scotopic condition with full refraction correction of refraction.

All examinations measured by an optometrist who was masked to the type of surgery in the same room. Data were analyzed by SPSS software version 16 (SPSS INC Chicago IL). Independent t-test was used to compare intergroup differences. We set the significance level at $P < 0.05$.

Results

A total of 106 eyes of 106 patients underwent PK or DALK for keratoconus included to study of them 57 underwent PK and 49 underwent DALK. For CSFs testing 8 eyes from PK and 4 eyes from DALK group excluded before VA lower than $20/40$ and data of 49 eyes in PK and 45 eyes in DALK groups were analyzed.

The mean age at operation in PK and DALK groups were 27.7 ± 9.5 and 27.8 ± 8.7 , respectively ($P = 0.6$). A total of 40 eyes (38%) were in female and 66 eyes (62%) were in male. Mean follow-up time in PK and DALK groups were 35.0 ± 2.4 months and 30.3 ± 2.5 months, respectively ($P = 0.17$). The mean postoperating uncorrected visual acuity (UCVA) in PK group was 0.68 ± 0.05 logMAR and in DALK group was 0.70 ± 0.05 logMAR ($P = 0.75$). BSCVA was also comparative in 2 groups and were 0.28 ± 0.04 logMAR and 0.28 ± 0.03 in PK and DALK groups, respectively ($P = 0.99$).

Postoperative BSCVA better than $20/40$ was 73.5% and 64.4% of eyes in PK and DALK groups, respectively ($P=0.21$). In PK group 12 eyes (24.5%) and in DALK group 4 eyes (9%) had VA $20/20$ ($P=0.04$).

The postoperative mean SE in PK and DALK groups were -2.74 ± 0.58 diopter (D) and -3.46 ± 0.52 D respectively ($P=0.36$). Mean topographic astigmatism in PK group was 3.81 ± 0.28 and in DALK group was 4.21 ± 0.42 ($P=0.42$). There was no statistically significant difference in SE and topographic astigmatism between the two groups.

The CSFs in all spatial frequencies was significantly lower in DALK group than PK group (Table 1 and Figure 1).

Table 1. Contrast sensitivity functions in penetrating keratoplasty and deep anterior lamellar keratoplasty

Spatial frequency	Mean \pm SD		P
	PK	DALK	
3 cpd	3.66 \pm 0.26	2.57 \pm 0.23	0.003
6 cpd	2.79 \pm 0.22	2.05 \pm 0.23	0.021
12 cpd	1.91 \pm 0.17	1.00 \pm 0.12	≤ 0.001
18 cpd	1.41 \pm 0.15	0.87 \pm 0.13	0.009

cpd: cycles per degree
PK: Penetrating keratoplasty
DALK: Deep anterior lamellar keratoplasty

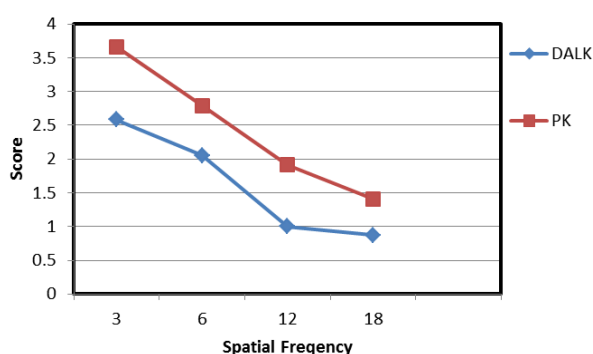


Figure 1. Contrast sensitivity functions in penetrating keratoplasty and deep anterior lamellar keratoplasty
PK: Penetrating keratoplasty
DALK: Deep anterior lamellar keratoplasty

During follow-up period one graft failed in PK group due to rejection. In contrast four grafts failed in DALK group. Two grafts failed for high irregular astigmatism, one for interface opacity and one for interface vascularization and opacity.

Discussion

Corneal graft for keratoconus has the highest rate of survival in all indications for keratoplasty.¹⁵ Endothelial rejection is the most common cause of graft failure after PK.¹⁶⁻¹⁸ DALK preserving the host endothelium and therefore eliminate the risk of endothelial rejection and so it has gained increased interest in the past decade.

Recent studies have shown that DALK yields visual and refractive outcomes similar to PK in keratoconic eyes⁹⁻¹¹ on the other hand some studies have been proposed that visual function is affected by DALK procedure.¹²⁻¹⁴ It has been proposed that irregularity in host-donor interface may influence visual function.

Our study shows that postoperative UCVA, BSCVA, SE and topographic astigmatism are comparable in PK and DALK in keratoconic eyes. These findings are compatible with recent papers that compare PK versus DALK. These papers showed more but statistically insignificant myopia in DALK in respect to PK.^{9-12,19,20} Our study also shows similar results but in our study postoperative mean astigmatism was higher in DALK group. Although the difference was not statistically significant, it was in contrast to previous studies in which there was a statistically insignificant lower cylinder in DALK group.⁹⁻¹⁴ This may attributed to surgeon's experience, it was shown that surgeon's experience had a known but small effect on postoperative astigmatism in corneal surgery.²¹⁻²³ In our study 73.50% of eyes in PK group and 64.45% of eyes in DALK group had VA of $20/40$ or better that is inferior to that of from Javadi et al⁹ study in which 95.5% in DALK and 97.1% in PK groups were achieved $20/40$ or better VA. In Fontana et al study¹⁰ in PK and bare decsmetes DALK groups 23% and 28% had BSCVA $20/20$ respectively but in eyes with layers of stroma left adherent to recipient cornea only 6% had $20/20$ vision. Funel et al²⁰ found that at 12 months follow-up in PK group 70% and in DALK group 22% had BSCVA $20/20$ or better. In this study DALK was performed using the Melles's technique also in Jones study¹⁴ 33% of patients with PK and 22% in DALK achieved $20/20$ vision respectively.

In our study CSFs were better in PK group in all frequencies (3, 6, 12 and 18 per degree) and the differences were statistically

significant. These findings are in contrast to Javadi et al⁹ and Silva et al¹¹ findings in those CSFs were similar in PK and DALK. This difference may be attributed to surgeon's experience. In our study all three surgeons had low experience in DALK procedure although in all cases that entered the study surgical notes showed bare DM during the operation but inadequate experience in managing interface for debris or fine stromal remnant adherent to DM may play an important role in light scattering and lower contrast sensitivity.

In fact light scattering at the graft-host interface due to an irregular interface, wrinkles of DM debris in interface or haze and opacity in interface is responsible for suboptimal visual function after DALK. Ardjomand et al¹³ showed that the recipient stromal thickness had significant effect on visual function after DALK, and it was decreased significantly with increasing the amount of recipient tissue thickness.

Fontana et al¹⁰ found that when layers of corneal stroma are left adherent to the DM, visual functions are inferior in DALK compared to PK.

In our study graft failure was more in DALK group than PK group (8% versus 1.7%) this is compatible with Jones et al¹⁴ findings in which the risk of graft failure for DALK was twice that

for PK, the difference is more in early period (first 90 days) and authors attributed it to surgeon's experience. Also in Hen at al¹⁹ study there was a significant difference in survival of PK and pre-desmetic DALK (100% versus 72.7%). In other studies there was no difference in graft failure and survival in PK and DALK.⁸ If we excluded high and irregular astigmatism in DALK group failure rate in PK and DALK groups were comparable. As Jones et al¹⁴ we attribute high graft failure in DALK to surgeon's experience.

In our study patients with uneventful postoperative course were entered to study to exclude factors that may influence visual function tests. According to our knowledge this is the first study that focuses and compares PK versus DALK in a teaching hospital in Iran. Our study has a retrospective and non randomized design so evidences of this study have some limitations.

Conclusion

In this study setting which is a university teaching hospital visual and refractive outcome in PK and DALK for keratoconus is comparable whereas CSFs are better in PK than DALK. Graft failure is higher in DALK than PK.

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