Original Article

Outcomes of keratoplasty in lattice corneal dystrophy in a large cohort of Indian eyes

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Purpose: The purpose of this study is to evaluate the outcomes of keratoplasty for lattice corneal dystrophy (LCD) performed at a tertiary eye care center. **Methods:** A retrospective review of medical records of those patients who were clinically diagnosed to have LCD (72 eyes of 57 patients) and underwent either penetrating keratoplasty (PK, 58 eyes of 46 patients) or deep anterior lamellar keratoplasty (DALK, 14 eyes of 13 patients) between the years 1987 and 2014 was performed. The main outcome measures included demographics, clinical features, and outcomes of keratoplasty. **Results:** The median follow-up after keratoplasty was 3.1 years (interquartile range [IQR], 9 months to 9 years). The median best-corrected visual acuity (BCVA) was 0.18 (IQR, 0.10–0.48) (Snellen equivalent 20/30 [IQR, 20/25–20/60]) at 4 years postoperatively and 0.65 (IQR, 0.18-0.95) (Snellen equivalent 20/89 [IQR, 20/30–20/178]) at 10 years following surgery. DALK eyes had a significantly better BCVA than PK eyes at 2 years following keratoplasty. The median overall survival of grafts was 15.8 years. Late complications included recurrence of LCD (14 eyes), graft infiltrate (23 eyes), graft rejection (15 eyes), graft failure (16 eyes), and glaucoma (14 eyes). **Conclusion:** The outcomes of graft are similar following PK and deep anterior lamellar keratoplasty; however, the latter appears to provide slightly better visual outcome. Recurrence of dystrophy in the graft and graft infiltrates limit the overall graft survival in both the groups.

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Lattice corneal dystrophy (LCD) is an autosomal dominant disorder of corneal stroma characterized by the accumulation of amyloid deposits.[1] It begins to manifest during the first or second decade of life affecting corneal transparency and is bilateral.[2-4] There have been few studies on the outcomes of penetrating keratoplasty (PK) or deep anterior lamellar keratoplasty (DALK) or both for LCD, but of a limited series with follow-up for few years.[4-6] Recurrences often develop following keratoplasty and require regrafts.[7-9] Here, we report the outcomes of keratoplasty for LCD performed on a large number of patients at a tertiary eye care center in South India.

Methods

The study was approved by the Institutional Ethics Committee and followed the tenets of Declaration of Helsinki. This study was a retrospective review of medical records of a tertiary eye care center in South India. Patients who were clinically diagnosed to have LCD (72 eyes of 57 patients) and underwent either PK (58 eyes of 46 patients) or big-bubble DALK (14 eyes of 13 patients) during the years 1987–2014 were included in the study [Fig. 1a and b]. These patients had the relevant study information documented during their visits and for those who were lost to follow-up in the postoperative period, the information until their final visits were collected. All the postoperative corneal buttons had been examined by an ophthalmic pathologist and had histopathological features consistent with LCD.

Data collected included demographics, clinical features, and outcomes of the first keratoplasty for LCD. The primary outcome measures assessed were preoperative, intra-operative, and postoperative clinical features after keratoplasty in LCD. The secondary outcome measure was to analyze the outcomes by the type of surgery (either PK or DALK). In those patients who had only 1 week of follow-up duration ($n = 2$ eyes), the parameters that were assessed were immediate postoperative outcomes and complications after keratoplasty. The study was from an institutional setup and several cornea faculty and trained fellows performed the surgeries. During initial years, PK was the favored modality of management. However, with the evolution of lamellar keratoplasty techniques, DALK became a preferred option as endothelium is healthy in LCD. Hence, the shift from PK to DALK in later years was an evolutionary change in lamellar surgery over full thickness keratoplasty. DALK procedure was performed by the big-bubble technique.

The postoperative care followed the standard practice pattern and guidelines advocated after keratoplasty. Broadly, the postoperative care involved topical steroids and antibiotics in the postoperative period, monitoring of suture-related issues,

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suture management, assessment of intraocular pressure (IOP), and graft clarity. The steroids were started on a four-hourly basis in the first postoperative week with a gradual tapering on a weekly basis till once or twice daily which was maintained for at least 2–3 years after keratoplasty. In steroid responders, loteprednol etabonate was used instead of prednisolone acetate. The postoperative follow-up periods (± variations) included day 1, week 1 (±1 day), week 2 (±2 days), month 1 (±3 days), month 3 (±1 week), month 6 (±2 weeks), year 1 (±1 month), and annually (±2 months) thereafter.

The pre- and post-operative visual acuities were documented either in Snellen notation or in logMAR scale in the records. The Snellen notations were converted into logMAR scales for analysis. The vision achieved following refraction was recorded as the best-corrected visual acuity (BCVA). Graft rejection was defined as graft edema in a previously clear graft corroborating with clinical symptoms and signs of rejection such as decrease in visual acuity, keratic precipitates, anterior chamber (AC) reaction, endothelial rejection line, stromal haze, and edema. Graft failure was defined as a loss of graft clarity and/or decrease in BCVA by two or more lines. Recurrence in the graft was characterized by features of lattice dystrophy such as rod-like deposits and lines in the graft.

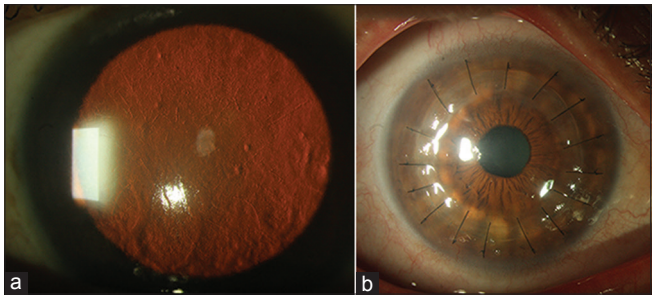

Figure 1: Clinical photographs (a) preoperative slit lamp retro illumination shows the lines and rod-like structures characteristic of lattice corneal dystrophy; (b) this figure shows the postoperative slit lamp diffuse illumination of the eye following penetrating keratoplasty for lattice corneal dystrophy

The software Origin v 7.0 (OriginLab Corporation, Northampton, MA, USA) was used to perform the statistical analysis. Normality of the continuous data and homoscedasticity were evaluated using Shapiro–Wilk and Levene tests, respectively. Mean (± standard deviation), and median (along with inter-quartile range [IQR]) were used to describe the parametric and nonparametric data, respectively. Comparisons between DALK and PK groups were performed using Fisher's exact test (categorical data), Mann–Whitney test (nonparametric data and parametric data with unequal variance), and *t*-test (parametric data with equal variance). Kaplan–Meier survival plots were performed for time-to-event analyses, and Cox proportional hazards model was used to evaluate the effect of covariates. $P < 0.05$ was considered statistically significant.

Results

Demographics and preoperative features

Table 1 summarizes the demographics and preoperative characteristics of the study patients. These features were comparable between PK and DALK participants.

Intraoperative features

A total of 46 (63.9%) underwent a single procedure (either DALK or PK), whereas 26 eyes (36.1%) had keratoplasty combined with another simultaneous intraocular intervention (extracapsular cataract extraction [ECCE; 21 eyes] or phacoemulsification (3 eyes), followed by posterior chamber intraocular lens (IOLs) implantation; anterior vitrectomy (AV; one eye), or only AV (an aphakic eye) followed by AC IOL). All patients had 16 interrupted sutures in both the groups.

Visual acuity and refraction

The median visual acuity before surgery was 1.30 (IQR, 1.00–1.79) (Snellen equivalent 20/400 [IQR, 20/200 to Counting Finger 1 m]). Overall postoperatively, the median BCVA was 0.40 (IQR 0.18–0.60) (Snellen equivalent 20/50 [IQR, 20/30-20/80]) at three months ($n = 61$), 0.18 (IQR, 0.10–0.48) (Snellen equivalent 20/30 [IQR, 20/25-20/60]) at four years ($n = 35$), and 0.65 (IQR, 0.18–0.95) (Snellen equivalent 20/89 [IQR, 20/30-20/178]) at 10 years ($n = 18$) following surgery [Fig. 2a].

Table 1: Demographics and preoperative features of lattice corneal dystrophy

Demographics	Overall	PK	DALK	*P* (PK vs. DALK)
Number of eyes	72	58	14	N/A
Number of patients	57***	46	13	N/A
Age at presentation (years), mean±SD	44.6±11.7	45.4±12.0	40.7±9.7	0.20
Male:female (%)	39 (68.4):18 (31.6)	31 (67.4):15 (32.6)	9 (69.2):4 (30.8)	1.00
Family history of corneal pathology (%)	16 (28.1)	13 (28.3)	3 (23.1)	1.00
UCVA at presentation, median (IQR)	1.00 (0.70-1.61)	1.00 (0.60-1.61)	1.00 (0.70-1.61)	0.99
Clear lens at presentation (%)	48 (66.7)	37 (63.8)	11 (78.6)	0.36
Age at surgery (years), mean±SD	47.2±10.2	47.4±10.6	46.3±8.2	0.73
Donor age (years), median (IQR)	59 (50-69)	58 (45-67)	64 (58-78)	0.046
Donor ECD (cells/mm^2), mean±SD	2602.1±399.8 (*n*=44)	2711.1±287.9 (*n*=37)	2026±433 (*n*=7)	<0.0001
Donor death-preservation time (h), median (IQR)	4.2 (3-5.5)	4 (2.8-5.5)	4.5 (3-5.5)	0.59
Donor size (mm), median (IQR)	8.2 (8-8.5)	8.2 (8-8.5)	8 (7.75-8.25)	0.10
Recipient size (mm), median (IQR)	7.7 (7.5-8)	7.7 (7.5-8)	7.5 (7.5-8)	0.77

This table summarizes the demographics and preoperative characteristics of the study patients. ***46 PK patients and 13 DALK patients added to a total of 57 patients because two patients had PK in one eye and DALK in another eye. PK: Penetrating keratoplasty, DALK: Deep anterior lamellar keratoplasty, N/A: Not applicable, SD: Standard deviation, UCVA: Uncorrected visual acuity, IQR: Interquartile range, ECD: Endothelial cell density

Fig. 2b shows the proportions of eyes having vision better than 20/40, 20/40–20/200, and worse than 20/200 preoperatively and at postoperative visits: Month 3, year 4, and year 10. None of the eyes had vision better than 20/40 before surgery, whereas there was a significant ($P < 0.001$) increase in the proportion of eyes with vision better than 20/40 after surgery: 24.5% at month 3, 44.8% at year 4, and 27.3% at year 10. Table 2 shows the BCVA obtained from month 3 through year 10. There was no significant difference at all visits until year 1; however, in year 2, DALK eyes had a significantly better BCVA than PK eyes. Table 3 summarizes the proportions of eyes having vision better than 20/40, 20/40–20/200 and worse than 20/200 at postoperative visits: months 3 and 6 and years 1 and 2 for DALK and PK. The proportion of patients having vision better than 20/40 was higher in DALK group at all visits.

Table 4 summarizes the mean spherical equivalent (MSE) refraction obtained from month 3 through year 10. Table 5 summarizes the astigmatism values obtained from month 3 through year 10. One eye in PK group (2.1%) had a MSE of-11 D at year 1.3 and arcuate keratotomy was done. Two eyes in PK group underwent relaxing incision with compression sutures (RICS) at years 1.7 (2.1%) and 3.1 (3.7%), respectively, for high astigmatism (>−10 D).

Postoperative course and outcomes

The median follow-up after keratoplasty was 3.1 years (IQR, 9 months to 9 years and range, 1 day to 21 years). The median follow-up in PK group was 4.2 years (IQR, 1.2–11.2 years and range, 1 day to 21 years) and in DALK group was 1.3 years (IQR, 9 months to 3.2 years and range, 7 days to 5.1 years). The immediate, early, and late postoperative

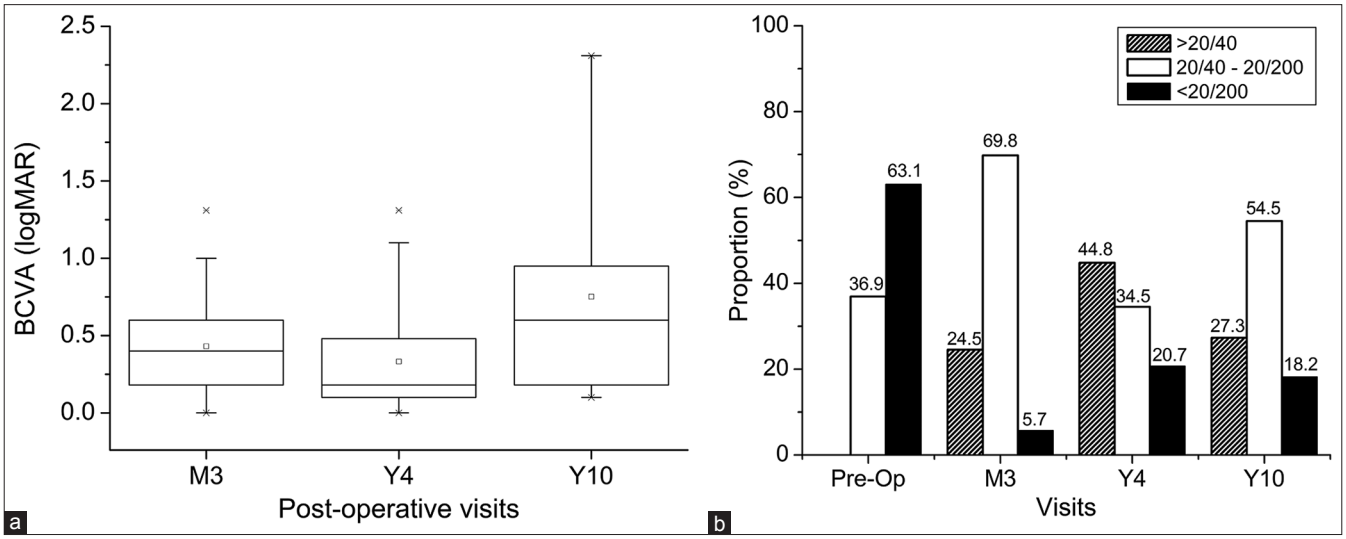

Figure 2: Visual outcome after keratoplasty for lattice corneal dystrophy (a) boxplot shows the trend in the distribution of BCVA at month 3 (M3), year 4 (Y4), and year 10 (Y10) following keratoplasty for lattice corneal dystrophy; (b) bar diagram shows the proportions of eyes having vision categorized by better than 20/40, 20/40-20/200, and worse than 20/200 at preoperative visit, month 3 (M3), year 4 (Y4), and year 10 (Y10) following keratoplasty for lattice corneal dystrophy

Table 2: Visual acuity following keratoplasty for lattice corneal dystrophy

Postoperative visit	Number of eyes		BCVA in logMAR, median (IQR)		
	PK	DALK	PK	DALK	*P*
Month 3	50 (PL in one eye)	12	0.40 (0.30-0.60)	0.35 (0.10-0.60)	0.57
Month 6	47	11	0.30 (0.18-0.48)	0.24 (0.00-0.90)	0.68
Year 1	43	11	0.30 (0.18-0.60)	0.20 (0.10-0.60)	0.60
Year 2	40	5	0.40 (0.18-0.60)	0.10 (0.00-0.10)	0.02
Year 3	36	4	0.40 (0.18-0.60)	0.14 (0.00-0.18)	N/A
Year 4	34	1	0.24 (0.10-0.48)	0.10	N/A
Year 5	28	1	0.30 (0.18-0.48)	0.18	N/A
Year 6	26	0	0.48 (0.18-1.00)	N/A	N/A
Year 7	23	0	0.60 (0.18-0.90)	N/A	N/A
Year 8	23	0	0.60 (0.40-1.30)	N/A	N/A
Year 9	21	0	0.40 (0.30-0.60)	N/A	N/A
Year 10	18	0	0.65 (0.18-0.95)	N/A	N/A

This table shows the BCVA obtained from month 3 through year 10 following keratoplasty for lattice corneal dystrophy. BCVA: Best-corrected visual acuity, IQR: Interquartile range, PK: Penetrating keratoplasty, DALK: Deep anterior lamellar keratoplasty, PL: Perception of light, N/A: Not applicable, LogMAR: Logarithm of the minimum angle of resolution

Table 3: Visual acuity following penetrating and deep anterior lamellar keratoplasty for lattice corneal dystrophy

Vision	Surgery	Month 3 (%)	Month 6 (%)	Year 1 (%)	Year 2 (%)
Better than 20/40	PK	20.9	31.7	45.9	35.5
	DALK	40	50	60	80
20/40-20/200	PK	74.4	63.4	51.4	64.5
	DALK	50	30	30	20
Worse than 20/200	PK	4.7	4.9	2.7	0
	DALK	10	20	10	0

This table summarizes the proportions of eyes having vision categorized by better than 20/40, 20/40-20/200 and worse than 20/200 at postoperative visits: months 3 and 6 and years 1 and 2 for DALK and PK. PK: Penetrating keratoplasty, DALK: Deep anterior lamellar keratoplasty

Table 4: Postoperative refraction following keratoplasty for lattice corneal dystrophy

Postoperative visit	MSE (mean±SD), in D						*P*
	Overall	*n*	PK	*n*	DALK	*n*	
Month 3	−0.39±3.13	34	−0.31±3.22	29	−0.87±2.82	5	0.72
Month 6	−0.73±3.66	41	−0.44±3.57	35	−2.44±3.99	6	0.22
Year 1	−1.47±3.82	43	−1.21±3.59	34	−2.42±4.72	9	0.41
Year 2	−1.29±3.01	29	−1.18±3.15	25	−2.00±2.13	4	N/A
Year 3	−1.88±2.95	22	−1.80±3.00	19	−2.42±3.18	3	N/A
Year 4	−2.27±2.96	22	−2.28±3.03	21	−2.00	1	N/A
Year 5	−1.33±2.99	17	−1.52±2.98	16	1.75	1	N/A
Year 6	−2.30±3.61	11	−2.30±3.61	11	N/A	0	N/A
Year 7	−2.44±1.74	6	−2.44±1.74	6	N/A	0	N/A
Year 8	−2.50±1.64	7	−2.50±1.64	7	N/A	0	N/A
Year 9	−1.25±2.81	10	−1.25±2.81	10	N/A	0	N/A
Year 10	−0.77±4.07	6	−0.77±4.07	6	N/A	0	N/A

This table summarizes the mean spherical equivalent refraction obtained from month 3 through year 10 following keratoplasty for lattice corneal dystrophy. MSE: Mean spherical equivalence, SD: Standard deviation, PK: Penetrating keratoplasty, DALK: Deep anterior lamellar keratoplasty, N/A: Not applicable

complications following keratoplasty for LCD are summarized in detail in Table 6, Figs. 3 and 4.

Discussion

LCD is associated with stromal deposits which increase with time and result in recurrent corneal erosions eventually leading to corneal scarring which necessitates keratoplasty. As the endothelium is healthy, deep anterior lamellar keratoplasty can be performed in these eyes. However, the stromal deposits can recur in the grafts, both PK and DALK, which can lead to increased risk of epithelial breakdown, infiltrates, and loss of graft transparency. The purpose of this study was to perform a comprehensive analysis of visual outcomes and survival analysis of grafts performed at a tertiary eye care center in South India for treating LCD. Although there are different types of lattice dystrophy, the study limits categorizing them as the data were collected retrospectively. Most of the eyes in this study had a PK. DALK popularized much later and so the follow-up duration was lesser in this subset of eyes.

The mean age at the time of keratoplasty in our study was 45 years. This correlates well with the published literature.[5] Around 28% of the patients had a family member affected by similar corneal pathology and one-third of the eyes had cataract. Hence, one-third of the keratoplasty for LCD is combined with cataract extraction in our series. In our study cohort, one patient had an uncontrolled IOP in the immediate postoperative period and in view of this, underwent a transscleral photocoagulation in the early postoperative period with good outcome.

We found that the BCVA was best at around 4 years following the surgery with a median visual acuity of 20/50. It decreased by more than two lines during 10th postoperative year, probably due to the development of late postoperative complications. Until the end of first postoperative year, there appears to be no significant difference in BCVA achieved by DALK and PK. At around 2 years following keratoplasty, DALK (median of 20/25) seems to offer better BCVA than PK (median of 20/50) but a larger sample size of DALK eyes is needed for strong conclusions. Kawashima *et al*. compared the therapeutic outcomes after deep lamellar keratoplasty and PK in LCD.[4] In their study, both procedures provided similar visual outcomes. During 10 years of follow-up in our study, the average spherical equivalence is stable around-2 D. Only a minor proportion of cases (<4%) developed high astigmatism and were appropriately managed by arcuate keratotomy or RICS.

Lattice dystrophy is known to recur in the grafts, and early recurrences can be missed. We analyzed the postoperative course for recurrences, epithelial problems, infections, and rejection episodes in the grafts. In our patients, the probability of developing the recurrence of disease increased with increasing postoperative follow-up period: 5% at 1 year, 26% at 8 years and 56% at 15 years following keratoplasty. The median survival period for recurrence was 15 years (95% confidence interval [CI], 9.2–15 years). Recurrences were found in 20.7% of PK and 14.3% of DALK cases. Lanier *et al*. never observed recurrent lattice figures, striae, or lines in any of the 34 primary PK performed in their series with follow-up of 14 years.[5] Pandrowala *et al*. too observed no recurrence in their series of 15 eyes with a mean follow-up of 33 months following PK.[3] Meisler and Fine found in their retrospective study of 61 PKs in LCD, clinical signs of recurrence in 48% of transplants after periods ranging from three to 26 years, average time to recurrence being 9 years.[8] In a retrospective review of 35 eyes with LCD by Marcon *et al*.,[9] there was a simple recurrence in 60% eyes following PK and the median time was 8.4 years (95% CI, 6.75–13.24). Similar to our study, the authors observed the potential for recurrence to increase with follow-up time. Considering only a 5-year period of follow-up, recurrence was observed in 12.5% of eyes in our series which was lesser than 17.8% observed by Marcon *et al*. In a series of 17 eyes that underwent DALK for LCD, Unal *et al*. noted recurrence in 35.3%.[6] It is possible that the recurrences may be related to the type of lattice dystrophy, one form more prone for recurrences than the others.

The chances of graft infection in the postoperative follow-up period were seen to increase with time in our series: 16% at one year, 30% at 5 years, and 60% at 10 years following surgery. Early changes in the graft could be a predisposing factor for epithelial defect and infections. There was no significant relationship between recurrence of lattice dystrophy and graft infiltrate ($P = 0.76$, Fisher's exact test). Recurrence was found in 21.7% (5/18) of eyes where infiltrate occurred and in 18.4% (9/40) of eyes where there was no graft infiltrate. Most of the cases of graft infiltrate (4 eyes) were secondary to suture-related issues [Table 6].

Table 5: Postoperative astigmatism following keratoplasty for lattice corneal dystrophy

Postoperative visit	Cylindrical refraction (mean±SD), in D						*P*
	Overall	*n*	PK	*n*	DALK	*n*	
Month 3	−4.82±4.99	34	−5.21±5.23	29	−2.55±2.58	5	0.28
Month 6	−3.96±3.25	41	−4.02±3.12	35	−3.63±4.27	6	0.79
Year 1	−4.21±2.80	43	−4.49±2.77	34	−3.17±2.83	9	0.21
Year 2	−3.78±3.02	29	−3.96±3.14	25	−2.63±1.97	4	N/A
Year 3	−4.22±3.11	22	−4.62±3.16	19	−1.67±0.88	3	N/A
Year 4	−4.44±3.86	22	−4.65±3.82	21	0.00	1	N/A
Year 5	−4.10±3.86	17	−4.33±3.87	16	−0.50	1	N/A
Year 6	−5.00±4.82	11	−5.00±4.82	11	N/A	0	N/A
Year 7	−5.63±2.74	6	−5.63±2.74	6	N/A	0	N/A
Year 8	−5.93±1.97	7	−5.93±1.97	7	N/A	0	N/A
Year 9	−3.80±1.64	10	−3.80±1.64	10	N/A	0	N/A
Year 10	−3.38±2.15	6	−3.38±2.15	6	N/A	0	N/A

This table summarizes the astigmatism values obtained from month 3 through year 10 following keratoplasty for lattice corneal dystrophy. SD: Standard deviation, PK: Penetrating keratoplasty, DALK: Deep anterior lamellar keratoplasty, N/A: Not applicable

Less than half of the grafts developed episodes of rejection at any given point of time in the followed up postoperative period: 7% at one year, 29% at seven years, and 45% at 14 years. A good majority of the grafts are clear for ten years following keratoplasty for LCD: 92% at two years, 84% at five years, and 62% at 10 years. In our series, half of the grafts survived for a period of ~16 years. In the series by Pandrowala *et al*.,[3] 86% of the grafts were clear at mean follow-up of 2.75 years (n = 15). Other events that occurred during the postoperative period such as raised IOP, PCO, and retinal complications are managed appropriately in our series.

Table 7 shows the comparison between our study and that by Kawashima *et al*.[4] Our study has double the sample size for PK, but only half for DALK as lamellar procedures were adopted recently in our tertiary eye care center. The ages of the participants who had keratoplasty procedures for LCD in our series were at least a decade younger than those of Kawashima *et al*. It is not known if there are regional differences in the clinical features of LCD. The rejection rates are comparable in both the studies. In our series, significant (P = 0.03) number of eyes failed (24%) in PK group than reported (3.5%) by Kawashima *et al*. Although

Table 6: Postoperative complications following keratoplasty for lattice corneal dystrophy

Postoperative complications	Time period	Number of eyes	Features
Immediate	1st postoperative week	DALK group - 5 eyes	DM detachment 3 eyes - DM reattached on conservative management within a month of surgery 1 eye - air descemetopexy was done; DM subsequently reattached 1 eye - air descemetopexy was planned; DM was found split intra-operatively; PK was performed
		PK group - 2 eyes	Raised IOP 1 eye - synechial closure, shallow AC, IOP 56 mmHg on day 1; synechiolysis and AC reformation were done; graft-host junction ectasia at week 2 - resuturing was performed 1 eye - PK + synechiolysis + ECCE; IOP 48 mmHg on day 1; transscleral photocoagulation was performed on day 4******
Early	2nd postoperative week to 2nd postoperative month	PK Group - 1 eye	Nonhealing persistent epithelial defect with infiltrate - therapeutic PK was performed in 4th week
		PK Group - 1 eye	Graft infiltrate at 1 month - resolved with medical management
		DALK group - 1 eye	Graft infiltrate at 1 month - resolved with medical management
Late	Beyond 2 months postoperative period	14 eyes - 2 eyes in DALK group and 12 in PK group	Recurrence of LCD Occurred within a mean duration of 6.1±4.4 years (range, 6 months to 15 years) Probability of recurrence-free grafts was 94.6%±3.1%, 86.5%±5.3%, 73.9%±8.2%, 53.1%±10.6% and 44.2%±12% at years 1, 4, 8, 10, and 15, respectively
		23 eyes - 4 eyes in DALK group and 19 in PK group	Graft infiltrate Occurred within a median duration of 2.1 years (IQR, 2.3 months to 6.2 years) Probability of infiltrate-free grafts was 91.1%±3.5%, 84.4%±4.6%, 70.4%±6.6%, 58.7%±8.3% and 41%±9.5% at month 3, years 1, 5, 8, and 10, respectively Herpes simplex virus (2 eyes); *Klebsiella pneumoniae* (1 eye); multi-drug resistant *Pseudomonas* (2 eyes); *Staphylococcus epidermidis* (2 eyes); *Streptococcus pneumoniae* (1 eye); Suture-related infection (4 eyes) Type of surgery (DALK or PK) had no influence on the development of graft infiltrate (P=0.20) Two PK grafts developed second infiltrate after an interval of 10 months and 7.2 years, respectively, the latter also had a third episode 11 months later

Contd...

Table 6: Contd...

Postoperative complications	Time period	Number of eyes	Features
		15 eyes - 1 eye in DALK group and 14 in PK group	Graft rejection Occurred within a median duration of 1.5 years (IQR, 1-6.6 years) Probability of rejection-free grafts following PK was 93.6%±3.6%, 84.4%±5.5%, 70.7%±7.8%, 62.3%±8.9% and 54.5%±10.7% at years 1, 3, 7, 10, and 14 respectively Similar analysis for DALK showed the probability of rejection-free grafts to be 88.9%±10.5% at year 3 Two PK grafts developed second episodes of rejection after an interval of 10 months and 7.3 years, respectively
		16 eyes - 2 eyes in DALK group and 14 in PK group	Graft failure Occurred within a mean duration of 7.8±6.1 years (range, 6 months to 18 years) Probability of graft survival was 91.8%±4%, 83.7%±5.8%, 71.1%±8.3%, 61.6%±9.5%, 52.8%±11.6%, 42.2%±13.2%, and 28.2%±14.5% at years 2, 5, 9, 10, 15, 16, and 17.7, respectively Median survival of grafts was 15.8 years None of the possible risk factors for graft failure (age at presentation, gender, age at surgery, death-preservation time or endothelial cell density of the donor tissue, type of surgery - DALK or PK, single surgery or combined with cataract extraction, recurrence of LCD, presence of infiltrate, episode of rejection and raised IOP) was significant (P>0.05)
		14 eyes - 3 eyes in DALK group and 11 in PK group	Raised IOP Occurred within a median duration of 9 months (IQR, 6 months to 1.6 years) DALK group - 1 graft required trabeculectomy; other two were controlled by antiglaucoma medications PK group - all were controlled with antiglaucoma medications One eye in PK group had three episodes at month 3, year 1 and year 14; also developed epitheliopathy at year 13; failed at year 18
		8 eyes	PCO Two (4.4%) of the single procedure (only keratoplasty) eyes, having had cataract extraction before keratoplasty, developed PCO at years 2.7 and 8.6, respectively Six (23.1%) of the combined (keratoplasty with cataract extraction) procedure developed PCO after a mean duration of 2±1.2 years (range, 8.4 months to 4 years) All PCO eyes underwent neodymium-doped yttrium-aluminum-garnet laser capsulotomy
		10 eyes	Cataract Surgery was performed within a median duration of 2.8 years (IQR, 1.5-9.3 years) Phacoemulsification - 8 eyes ECCE - 1 eye Small incision cataract surgery - 1 eye
		1 eye	Vitreomacular traction at month 10; at year 6, panretinal photocoagulation was performed for active proliferative diabetic retinopathy
		1 eye	Partial retinal detachment, at year 5, was repaired by a scleral buckle; however, 5 months later, buckle was removed following development of an infection

This table summarizes immediate, early and late postoperative complications following keratoplasty for lattice corneal dystrophy. ******One of the immediate postoperative complications that occurred in the PK group was post-PK glaucoma. The patient had a high IOP of 48 mmHg, coagulum in anterior chamber, and a vision of hand movements on the first postoperative day. In view of the uncontrolled IOP affecting vision, transscleral photocoagulation was performed on Day 4 as per the advice of glaucoma surgeons. DALK: Deep anterior lamellar keratoplasty, DM: Descemet's membrane, PK: Penetrating keratoplasty, IOP: Intraocular pressure, AC: Anterior chamber, ECCE: Extracapsular cataract extraction, LCD: Lattice corneal dystrophy, IQR: Interquartile range, PCO: Posterior capsular opacification

gender, duration of follow-up, cataract surgery rates during follow-up and rejection rates are comparable in both the series, presence of a large number of patients who are a decade younger may be one of the reasons for the observed high failure rate in our series. Similar to our study, both DALK and PK provided similar graft survival in the series by Kawashima *et al*.

The strength of this study is that it evaluates the keratoplasty outcomes in a large cohort of patients of Indian ethnicity operated at a single center. There are certain issues specific to geographical locations which are relevant while looking at the keratoplasty outcomes. Most of the reported studies have been from other centers in the world and not from India. In addition, most studies were on stromal dystrophies including

Table 7: Comparison of the present study with a previous literature

Features	DLK		PK	
	Present study	Kawashima *et al.*	Present study	Kawashima *et al.*
Number of eyes	14	31	58	29
Age (years), mean±SD	40.7±9.7	59±15	45.4±12.0	59±12
Male:female	2.25:1	2.9:1	2.1:1	1.9:1
Follow-up (years), mean (IQR)	1.8 (0.8-3.0)	1.8 (0.5-7.5)	6.4 (1.2-11.2)	4.2 (0.5-12.4)
History of cataract surgery (%)	1/14 (7.1)	2/31 (6.5)	3/58 (5.2)	Not known
Rejection (%)	1/14 (7.1)	0/31 (0)	14/58 (24.1)	6/29 (20.7)
Graft failure (%)	2/14 (14.3)	0/31 (0)	14/58 (24.1)	1/29 (3.5)
Cataract surgery during follow-up (%)	2/14 (14.3)	6/31 (19.4)	8/58 (13.8)	6/29 (20.7)

This table shows the comparison between our study and that by Kawashima *et al.* DLK: Deep lamellar keratoplasty, PK: Penetrating keratoplasty, SD: Standard deviation, IQR: Interquartile range

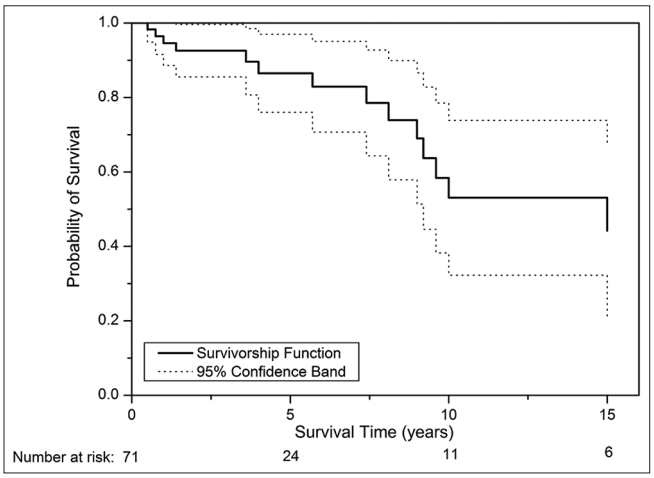

Figure 3: Survival analysis of graft recurrence: This figure shows the probability of recurrence-free grafts following keratoplasty for lattice corneal dystrophy

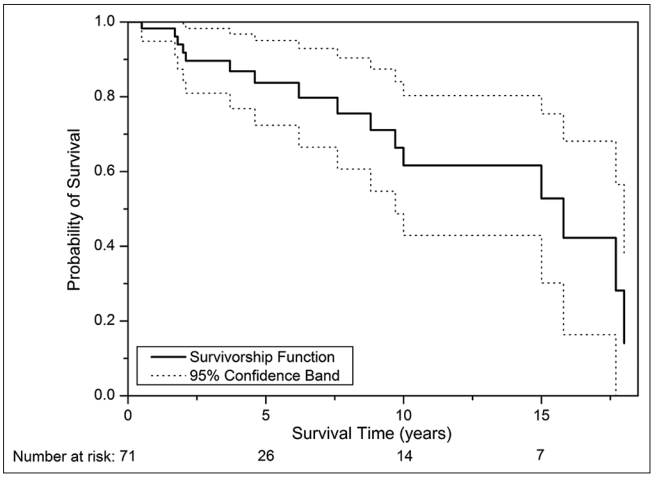

Figure 4: Survival analysis of graft failure: This figure shows the probability of survival of grafts following keratoplasty for lattice corneal dystrophy

both lattice and macular corneal dystrophy. This study is focused specifically on LCD.

Conclusion

The outcomes of graft are similar following PK and deep anterior lamellar keratoplasty, but the latter appears to provide slightly better visual outcomes. The challenges that come in way are the recurrences and graft infections, which can limit the overall graft survival in both the groups.

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Conflicts of interest

There are no conflicts of interest.

References

1. Sridhar MS, Laibson PR, Eagle RC Jr., Rapuano CJ, Cohen EJ. Unilateral corneal lattice dystrophy. Cornea 2001;20:850-2.
2. Laval J, Lloyd RI. Successful corneal transplants in four eyes of two patients with lattice dystrophy. AMA Arch Ophthalmol 1955;53:884-8.
3. Pandrowala H, Bansal A, Vemuganti GK, Rao GN. Frequency, distribution, and outcome of keratoplasty for corneal dystrophies at a tertiary eye care center in South India. Cornea 2004;23:541-6.
4. Kawashima M, Kawakita T, Den S, Shimmura S, Tsubota K, Shimazaki J, *et al.* Comparison of deep lamellar keratoplasty and penetrating keratoplasty for lattice and macular corneal dystrophies. Am J Ophthalmol 2006;142:304-9.
5. Lanier JD, Fine M, Togni B. Lattice corneal dystrophy. Arch Ophthalmol 1976;94:921-4.
6. Unal M, Arslan OS, Atalay E, Mangan MS, Bilgin AB. Deep anterior lamellar keratoplasty for the treatment of stromal corneal dystrophies. Cornea 2013;32:301-5.
7. Klintworth GK, Ferry AP, Sugar A, Reed J. Recurrence of lattice corneal dystrophy type 1 in the corneal grafts of two siblings. Am J Ophthalmol 1982;94:540-6.
8. Meisler DM, Fine M. Recurrence of the clinical signs of lattice corneal dystrophy (type I) in corneal transplants. Am J Ophthalmol 1984;97:210-4.
9. Marcon AS, Cohen EJ, Rapuano CJ, Laibson PR. Recurrence of corneal stromal dystrophies after penetrating keratoplasty. Cornea 2003;22:19-21.