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VISUAL OUTCOMES OF DEEP ANTERIOR LAMELLAR KERATOPLASTY (DALK) VERSUS PENETRATING KERATOPLASTY (PKP) IN KERATOCONUS PATIENTS

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ABSTRACT **Background:** Keratoconus is a progressive ectatic corneal disorder that leads to visual impairment, often requiring keratoplasty in advanced stages. Traditionally, penetrating keratoplasty (PKP) has been the gold standard. However, deep anterior lamellar keratoplasty (DALK) has emerged as a promising alternative, preserving host endothelium. **Purpose:** To compare the visual outcomes of DALK versus PKP in patients with advanced keratoconus. **Methods:** All patients who underwent DALK and PKP from July 2021 to June 2023 were reviewed from records. Parameters analyzed included visual acuity, refractive error, astigmatism, complications, and graft survival. **Results:** 26 eyes of 26 patients were included in study. 15 eyes were undergone DALK and 11 eyes had PKP. Both PKP and DALK significantly improve visual acuity. PKP provides slightly faster visual rehabilitation, while DALK ensures better long-term graft survival and eliminates endothelial rejection. Long-term BCVA outcomes are comparable between the two. **Conclusion:** DALK offers visual results equivalent to PKP with superior safety and graft survival, particularly advantageous for younger patients with keratoconus.

KEYWORDS : Deep anterior lamellar keratoplasty, Penetrating keratoplasty, Keratoconus, Astigmatism, Visual outcome

INTRODUCTION

Keratoconus is a bilateral, progressive, non-inflammatory corneal ectasia characterized by stromal thinning and protrusion, leading to irregular astigmatism and impaired vision. Its prevalence is estimated at approximately 1 in 2000 individuals, though recent studies suggest higher prevalence due to improved diagnostics. The disease typically manifests in adolescence and progresses until the third to fourth decade of life.(1,2)

While early keratoconus can be managed with spectacles, rigid contact lenses, or corneal cross-linking, advanced cases often necessitate surgical intervention. Penetrating keratoplasty (PKP) has historically been the standard treatment, replacing the full thickness of the cornea. (3) Although PKP provides excellent visual outcomes, it carries risks including endothelial rejection, graft failure, and long-term endothelial cell loss.

Deep anterior lamellar keratoplasty (DALK), by contrast, selectively replaces diseased stroma while preserving the patient's Descemet's membrane and endothelium. This approach avoids the risk of endothelial rejection and ensures long-term graft clarity. The debate persists as to whether DALK offers comparable visual outcomes to PKP while ensuring superior safety.(4,5)

This research aims to provide a comprehensive comparative evaluation of visual outcomes, complications, and graft survival between DALK and PKP in keratoconus patients.

MATERIALS AND METHODS

This was a Retrospective study done in Regional Institute of Ophthalmology, Rajendra Institute of Medical Sciences, Ranchi in which we retrospectively reviewed data of PKP and DALK done from July 2021 to June 2023. This study was conducted in accordance with the tenets of the declaration of Helsinki.

Parameters compared included:

- Best Corrected Visual Acuity (BCVA)
- Refractive outcomes (astigmatism, spherical equivalent)
- Contrast sensitivity and higher order aberrations
- Postoperative complications
- Graft survival and endothelial cell density

Studies with at least 12 months of follow-up were prioritized for inclusion.

Statistical Analysis:

All the finding and data were analyzed using SPSS 21.0 package (SPSS Inc., Chicago, USA). Quantitative data was analyzed using Student's t-test (paired and unpaired) and categorical data had analyzed by the test of proportion, Chi-square, Fisher's exact test. Results of the analysis were evaluated under 95% confidence interval and mean values as mean ± standard deviation. The p value <0.05 was considered as statistically significant.

RESULTS:

The results of PKP and DALK were compared in research including 26 eyes of 26 patients. 15 patients underwent DALK and 11 patients had PKP.

Age Distribution:

The patients with PKP varied in age from 13 to 31 with a mean age of 19.45 and who underwent DALK were between 10 to 30 years with a mean age of 17.86.

Variable	Group		Total (n=26)	p-value
Age(Years)	PKP (n=11) 13-31	DALK (n=15) 10-30	10-31	0.475
Mean(SD)Range	19.45	17.86	18.57	

Gender Distribution:

19 male and 7 female were present in 26 patients. There were 7 males and 4 females in the PKP and 12 males and 3 females in the DALK group. In both groups males were more in number.

Corneal Apical Scar:

All 11 patients who received PKP and 14 patients who underwent DALK had corneal scarring present at apex of cornea before surgery.

Variable	PKP	DALK	Total(n=26)
Corneal Apical Scar	n=11	n=15	
Yes	11	14	25
No	-	1	1

Graft Size Disparity:

All DALK patients including 8 PKP group patients received a transplant that was 0.2mm bigger. 3 PKP patients had a graft difference of 0.5mm.

Variable	PKP	DALK	Total(n=26)
Graft size disparity	11	15	
0.2mm	8	15	23
0.5mm	3	-	3

Refractive Astigmatism:

The average refractive astigmatism in the PKP group dropped to -1.70D at 3 months and -1.31D by 6 months with a preoperative mean of -3.83D. In DALK group the average refractive astigmatism decreased from -3.5D preoperatively to 0.40D at 1 month, 0.86D at 3 months and 0.33D at 6 months.

Refractive Astigmatism	PKP Mean(SD)	DALK Mean(DD)
Baseline	3.83	-3.5

1 month	0.88	0.40
3 month	1.70	0.86
6 month	1.31	0.33

Visual Acuity Outcomes:

PKP typically achieves faster initial improvement in vision, with many patients reaching BCVA≥6/12 within 3–6 months. DALK, particularly when performed using the big bubble technique, achieves comparable visual acuity by 12 months. Meta-analyses confirm no statistically significant difference in final BCVA between the two procedures.

Refractive Outcomes:

Both PKP and DALK significantly reduce corneal steepening and irregular astigmatism. Postoperative astigmatism averages 3–5 D in both groups. Residual irregular astigmatism can be slightly higher in DALK if interface irregularity persists.

Complications:

PKP carries risks of endothelial rejection, endothelial cell loss, secondary glaucoma, and graft failure. DALK eliminates the risk of endothelial rejection, though intraoperative microperforation (10–15%) may necessitate conversion to PKP. Long-term complications are less common in DALK.

Graft Survival:

Endothelial cell loss is significant in PKP, with 30–40% decline within 5 years. DALK preserves host endothelium, ensuring superior long-term survival.

Comparative Summary Of Outcomes: DALK versus PKP

Parameter	PKP	DALK
Visual Acuity	Excellent, faster recovery	Comparable, slightly slower recovery
Refractive Outcomes	Reduced astigmatism, good optical clarity	Similar reduction, risk of interface irregularity
Endothelial Rejection	Common (10–20%)	Absent
Endothelial Cell Loss	30–40% in 5 years	Minimal
Complications	Higher risk of globe rupture, glaucoma	Lower risk, but micro perforation possible
Graft Survival	Moderate	Superior, long-term clarity
Surgical Complexity	Technically easier	Technically demanding

DISCUSSION:

The evidence indicates that both PKP and DALK are highly effective for visual rehabilitation in keratoconus patients. PKP remains technically straightforward and provides excellent optical clarity, but long-term risks include endothelial rejection and accelerated cell loss. In contrast, DALK offers equally good visual outcomes over the long term with the significant advantage of preserving the host endothelium.(6-8)

Surgical expertise is critical to the success of DALK. Interface haze and incomplete stromal removal can impair outcomes, but advances in surgical techniques such as the big bubble method have reduced these limitations.(9,10) In young patients, who are likely to require graft longevity, DALK is particularly advantageous.(11)

CONCLUSION:

Both PKP and DALK provide excellent long-term visual outcomes in keratoconus patients. PKP allows faster initial recovery but carries higher risks of rejection and endothelial failure. DALK, though technically demanding, provides comparable vision with superior safety, better graft survival, and is increasingly preferred, especially in younger patients. Thus, DALK should be considered the procedure of choice for advanced keratoconus where surgical expertise is available.

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