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Original Research Article

Comparison of penetrating keratoplasty versus lamellar keratoplasty for macular corneal dystrophy: a retrospective study of a single-center experience

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ABSTRACT

Background: Although penetrating keratoplasty (PK) still remains the dominant form of transplantation for macular corneal dystrophy (MCD) patients, many studies evaluating these new forms of selective lamellar keratoplasty (LK) now suggest equivalent or better visual outcomes. This study aimed to explore the difference in outcomes and complications that follows each type of these operations.
Methods: A retrospective, single-center study was performed at King Abdulaziz medical city in 2022. The study included patients with a histological diagnosis of MCD who undergone either PK or LK. Data was collected from health records using a form that consisted of patient characteristic, type of operation and post-operative outcomes, including visual acuity, survival rate and complications.
Results: The study included a total of 54 eyes of patients who have MCD. A best corrected visual acuity (BCVA) of 0.5 or better was achieved in 82.5% of eyes of PK group and 42.9% of eyes of LK group. Graft survival rate was 90% (36 eyes) and 85.7% (12 eyes) in PK and LK groups respectively. Regarding complications, four PK eyes (10%) and one LK eye (7.1%) had high intraocular pressure, three PK eyes (7.5%) and one LK eye (7.1%) developed rejection, one PK eye (2.5%) developed recurrent epithelial erosion, and another one PK eye (2.5%) developed Traumatic epithelial laceration.
Conclusions: PK operations resulted in a better post-operative visual acuity compared to LK group. The graft survival rate was slightly better for the PK group. PK was associated with higher incidence of complications than LK group.

Keywords: Keratoplasty, Lamellar, Penetrating, Saudi

INTRODUCTION

Penetrating keratoplasty (PK) is a corneal transplant, or graft, in which the whole thickness of the cornea is replaced. Both classic posterior lamellar keratoplasty (LK) and endothelial keratoplasty procedures transplant the inner layers of the cornea.[1] Corneal transplantation has progressed dramatically in recent years, thanks to the introduction of novel kinds of LK that completely change the field. Descemet's stripping automated endothelial keratoplasty has developed as a prominent kind of endothelial replacement to address endothelial dysfunction, whereas anterior LK has re-emerged with novel variants of deep anterior LK.[1-3]

Although PK remains the dominant form of transplantation in almost all countries, many studies evaluating these new forms of selective LK now suggest equivalent or better visual outcomes, reduced allograft rejection rates, and longer-term graft survival with these lamellar procedures.[4] The use of different types of lamellar replacement varies greatly among geographic

regions and continents, as well as between industrialized and developing countries. Adoption rates are influenced by a variety of factors, including surgical training in these new procedures, access to lamellar-dissected donor tissue (for endothelial keratoplasty) as well as appropriate instrumentation, relative cost issues, and, of course, variability in the types and severity of corneal diseases affecting specific populations.[4]

Corneal dystrophies are a set of bilateral, genetically, non-inflammatory disorders that are restricted to the cornea in the majority of instances.[5] MCD is a progressive autosomal recessive condition marked by stromal opacities with indistinct borders.[6] MCD is the most frequent corneal dystrophy in Saudi Arabia, while being less common than other forms of stromal dystrophies worldwide. This is attributed to the region's greater consanguinity rate.[5,7] MCD is also the most common stromal dystrophy in India, Iceland, and parts of the United States.[5]

In the past, PK has been used to restore visual acuity in MCD patients with great results. Several anterior LK procedures, such as deep anterior LK, have been described due to the possibility of endothelium rejection and intraocular complications. A common approach for this complication is "Big bubble," which was first presented by Dr. Anwar in 1974 and thoroughly documented by Anwar and Teichmann in Saudi Arabia in 2002. This procedure entails partial-thickness trephination followed by air injection into the corneal stroma to create a large bubble between the Descemet's membrane and the corneal stroma.[8] In MCD without descemet's membrane or endothelium involvement, deep anterior LK is considered an alternative to PK.[9] Despite the fact that deep anterior LK has a number of advantages over PK, some researchers believe it is not a good choice for MCD because of the higher rate of interface opacity and endothelial cell loss.[10] According to a retrospective comparison study, deep anterior LK was associated with higher MCD recurrence and worse visual acuity than PK.[11] However, two further comparison investigations found that deep anterior LK had comparable visual results and was safer.[12,13]

This study aimed to compare BCVA, graft survival, graft failure, complications and recurrence rate in PK and LK as treatment options for patients with MCD.

METHODS

This cross-sectional, comparative study was conducted at King Abdulaziz medical city in Riyadh, Saudi Arabia during the period from 15 Jan 2022 to 30 Jul 2022. We included data retrospectively from medical records of patients with MCD. The inclusion criteria constituted of patients diagnosed with MCD with histopathologic confirmation and undergone either PK or LK operation in King Abdulaziz medical city, where follow-up data must be present. The exclusion criteria constituted of patients whose diagnoses were not confirmed through histopathological confirmation. Patients with other chronic ophthalmic conditions were also excluded from the study.

Data was collected from medical records using a form that consisted of patient sex, age, history of chronic conditions, date of diagnosis of MCD, management plan, type of transplant, date of operation, follow-up data on 6, 12 and 24 months, graft survival, graft failure, complications and recurrence. For any patient who have both of their eye operated on, we anlyezed data of each eye independently.

SPSS was used to analyze the data. Descriptive statistics were used to summarize the characteristics of the participants. Regarding visual outcomes, the postoperative BCVA of 0.5 or above was calculated for each type of operations and the percentages were provided. The logarithm of minimal angle of resolution (logMAR), which also represents the visual acuity, was calculated preoperatively, postoperatively, at 6 months, at 12 months, and at 24 months; and presented as means and standard deviations. LogMAR is calculated from the logarithm of BCVA; a low logMAR values indicates better visual acuity and good vision. Independent sample T test and Mann-Whitney-U test were used to compare the logMAR of each type of operations and a p-value less than 0.05 was considered statistically significant. The graft survival, recurrence, and complications at end of follow up period were presented as frequencies and percentages. The graft survival rate during the two years of follow up was also presented in a survival graph.

The authors obtained approval from the institutional review board (IRB) of King Abdullah international medical research Center, Riyadh, Saudi Arabia. The study did not include any personal information that identifies the patients as name, contact information, or addresses.

RESULTS

The study included a total of 54 eyes from 46 patient who have MCD confirmed by histopathology. Out of these 46 patients, 12 (24%) were females and 34 (74%) were males. The mean age of the patients was 31.9±6.3 years. Lamellar Keratoplasty (LK) was performed in a total of 14 eyes (14 patients), while PK was performed in a total of 40 eyes (35 patients). Eight patients underwent operation for both of their eyes, out of which three patients underwent 2 different types of operation (LK for one eye and PK for the other). The mean follow-up period was 1.9±0.7 years (2.1±0.8 years for LK group and 1.9±0.8 for PK group) (Table 1).

Table 2 and Figure 1 present the pre-operative, and post-operative outcomes of LK and PK operations at 6, 12 and 24 months of follow-up. A BCVA of 0.5 or better was achieved in 82.5% of eyes of PK group and 42.9% of eyes of LK group. There is a statistically significant

difference in the post-operative logMAR of BCVA between the two groups. PK group resulted in a better BCVA scores compared to LK group throughout the 2 years of follow-up ($p<0.05$).

At the latest follow-up, graft survival rate was 90% (36 eyes) and 85.7% (12 eyes) in PK and LK groups respectively (Figure 2).

As Shown in Table 3, significant recurrence was found on 2.5% (1 eye) and 14.3% (2 eyes) in PK and LK groups respectively. Regarding complications, 4 PK eyes (10%) and 1 LK eye (7.1%) had high intraocular pressure (IOP), 3 PK eyes (7.5%) and 0 LK eye (0.0%) developed rejection, 1 PK eye (2.5%) developed recurrent epithelial erosion, and another 1 PK eye (2.5%) developed traumatic epithelial laceration.

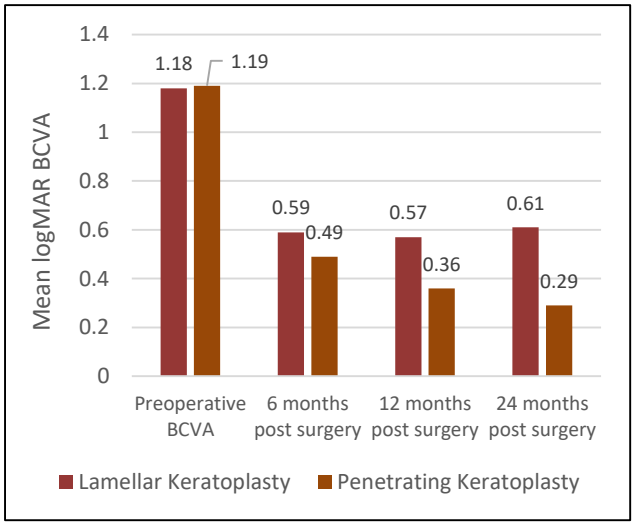

Figure 1: Mean logMAR of BCVA for LK group and PK group during 2-year follow-up.

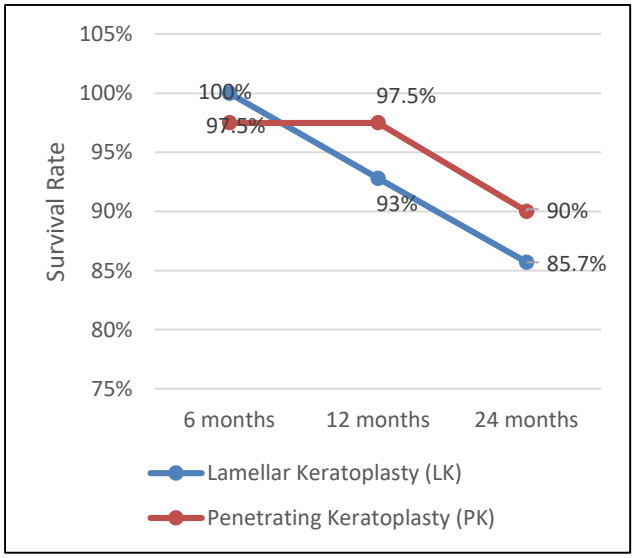

Figure 2: Graft survival rate during 2-year follow-up for LK group (n=14) and PK group, (n=40).

Table 1: Characteristic of the participants in the LK group and PK group.

Characteristic	Total	LKP, (n=14)	PK, (n=40)
Gender (n=46) (%)			
Male	34	11 (27.5)	29 (72.5)
Female	12	3 (21.4)	11(78.6)
Age (Years) (mean ± SD)	31.9±6.3	30.6±5.9	32.4±6.4
Follow-up period (Years) (mean ± SD)	1.9±0.7	2.1±0.8	1.9±0.8

Table 2: Preoperative and postoperative logMAR of BCVA for LK and PK group during 2-year follow-up.

Visual outcome	LKP, (n=14)	PK, (n=40)	P value
Mean preoperative logMAR BCVA	1.18±0.12	1.19±0.11	0.760
Mean logMAR BCVA at 6 months	0.59±0.15	0.49±0.18	0.042
Mean logMAR BCVA at 12 months	0.57±0.19	0.36±0.22	0.000
Mean logMAR BCVA at 24 months	0.61±0.31	0.29±0.34	0.001

Logarithm of minimal angle of resolution, which is an index of visual acuity.

Table 3: Graft survival, recurrence, and complications for LK group and PK group at end of 2-year follow-up, (n=54).

Characteristic	N (%)	LKP, (n=14) (%)	PK, (n=40) (%)
Graft survival rate	48 (88.9)	12 (85.7)	36 (90)
Recurrence on graft			
Insignificant recurrence	5 (9.3)	2 (14.3)	3 (7.5)
Significant recurrence	3 (5.6)	2 (14.3)	1 (2.5)
Complications			
High IOP	5 (9.3)	1 (7.1)	4 (10)
Recurrent epithelial erosions	1 (1.9)	0 (0.0)	1 (2.5)
Rejection	3 (6.9)	0 (0.0)	3 (7.5)
Traumatic epithelial laceration	1 (1.9)	0 (0.0)	1 (2.5)

DISCUSSION

MCD is a rare, autosomal recessive disease of the eyes that result from abnormal proteoglycans synthesis.

Surgical intervention may be indicated if patients developed severe visual impairment or discomfort from recurrent corneal epithelial micro-erosions.[14] Two types of operations, PK and LK have been used to improve the visual acuity in these patients, to relieve their symptoms, or both.[11] However, the preferred surgical operation for the management of MCD has not been established clearly yet. In this study we explored the difference in outcomes, as well as the complications that follows each type of operation in King Abdulaziz medical city, Riyadh, Saudi Arabia.

The distribution of eyes that underwent LK and PK operations was not equally distributed (14 eyes for LK and 40 eyes for PK). A similar pattern was also noted in a Saudi study by Al Araj et al and another study by Reddy et al which both included higher number of PK eyes compared to LK eyes.[12,15] Al Araj et al relate this difference to surgeon experience and preference, as well as to technical difficulties and the longer time to perform LK operations. Also concerns about the recurrence rate of LK operations had also been thought to be a contributing factor.[15]

Our result showed that both types of operations significantly improved the BCVA, indicating that they are very effective for improving the visual acuity of MCD patient. However, there is slight advantage in the post-operative BCVA for eyes that underwent PK compared with the eyes that underwent LK. This difference was more profound during the end of the 2-year follow-up. In addition, the graft survival rate was also slightly better for the PK group compared with the LK group (90% vs 85.7% at the end of 2-year follow up). Both significant and insignificant recurrence were higher for LK group.

According to literature, the great majority of studies that compared the outcomes of both LK and PK operations reported that there was no statistically significant difference in the post-operative BCVA between the two groups.[10,16–21] Al Araj et al in their study in Saudi Arabia also did not find any significant difference in post-operative BCVA between PK and LK group and suggested that LK operations had comparable medium-term visual and survival outcomes to PK group. They reported that LK, however, has the advantage of lower open sky intraoperative complications and lower graft rejection events.[15]

When superiority for either type of operation was noted in literature, PK usually yielded a better post-operative BCVA results, which is in concordance with our result.[22,23] For example, Ardjomand et al reported that eyes after PK operations had better visual acuity than eyes after LK operations (p=0.018), and the level of success of LK was dependent on the thickness of residual recipient stromal bed.[23] However, a recent study in Saudi Arabia found a better post-operative BCVA following LK operations.[24] Abdelaal et al found a superior BCVA outcomes of LK operations as well as an advantages of less frequent post operative complications such as IOP elevations, graft rejection, and graft failure.[24]

Regarding complications, our result showed higher incidence of post-operative complications following PK operations. In fact, four PK eyes (10%) had high intraocular pressure (IOP), three PK eyes (7.5%) developed rejection, one PK eye (2.5%) developed recurrent epithelial erosion, and another one PK eye (2.5%) developed traumatic epithelial laceration. This is in comparison to one LK eye (7.1%) that had high intraocular pressure (IOP) only. Our result is in agreement with previous published reports the highlighted the increased complications following PK 24. This show that, although PK operations resulted in a better post-operative BCVA, it carries with it a higher rate of complications.

Overall, major complications following PK operations include increased intraocular pressure, as well as graft rejection, micro-perforations and complicated cataract, which can occur intra-operatively or post-operatively. These occur more frequently than those that occur after LK operations, almost certainly because the intraocular tissues are not disturbed during LK.[18] In addition, the prolonged use of steroids following PK is thought to be a significant contributor to the development of complications, as steroid may precipitate increased IOP.[25] To avoid this complication, studies suggested a less aggressive steroid use with shorter time to graft stability to ease the burden of surgery for both patients and ophthalmologists.[21]

CONCLUSION

PK may improve the BCVA and quality of vision immediately in patients with MCD, However, the incidence of complications seems to be significantly higher than with LK. Comparatively poor post-operative BCVA and recurrence of the disease are major problems with LK operations. The graft survival rates between eyes treated by PK and LK for MCD were close to each other (90% vs 86% respectively). Therefore, selection of specific keratoplasty operation for MCD should consider the better visual acuity of PK and the lesser complications of LK. Younger patients who suffer from severe MCD, may benefit from PK for immediate improvement in visual function, whereas for older patients should avoid the expected complications and go for LK operation.

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