



# Visual Outcome after Lamellar Keratoplasty at Benghazi Eye Teaching Hospital

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## Abstract

**Purpose:** To evaluate the visual, refractive, and topographic improvement after deep anterior lamellar keratoplasty (DALK) in keratoconic patients. **Setting:** Benghazi Eye Teaching Hospital. **Design:** A prospective cohort study was done in the period from November 2023 to January 2024 and included 30 keratoconic eyes of 30 patients who underwent DALK. **Methods:** Thirty keratoconic eyes from 30 patients who underwent DALK. Preoperative data include uncorrected visual acuity (UCVA) and corrected distance visual acuity (CDVA), keratometry, and Q value. Postoperative UCVA and CDVA were evaluated at 7, 30, 60, and 90 days, with CDVA, keratometry, and Q-value using topography images at 90 days postoperatively. **Inclusion Criteria:** Moderate to severe keratoconus with the steepest K reading > 45 D based on the keratoconus study; age from 17 to 57 years; patients who can keep up follow-up for 3 months after surgery; minimum corneal thickness of 260  $\mu\text{m}$  at the thinnest corneal location. **Exclusion Criteria:** Pregnancy or nursing, history of hydrops, retinal or macular diseases, optic nerve pathologies, trauma, or amblyopia, and evidence of infectious corneal disease in the eye to be operated on. **Results:** There were statistically improved postoperative compared to preoperative parameters in UCVA and CDVA at the first week ( $P < 0.05$ ). Similarly, at 30, and 60 days. As well as at 90 days, parameters improved in the UCVA, CDVA, refractive, and topographic data. **Conclusion:** DALK is efficient for treating keratoconus. It improves UCVA and CDVA in patients with anterior corneal pathology. Faster wound healing is associated with a better donor-recipient fit.

## Subject Areas

Ophthalmology

## Keywords

Visual Acuity, Keratometry, Q Value, Keratoconus, Deep Anterior Lamellar

## 1. Introduction

Deep anterior lamellar keratoplasty (DALK) is a type of lamellar keratoplasty that rejoins the stroma to the Descemet's membrane in cases where the stroma is in danger of loss. In eyes with a healthy endothelium. Lamellar keratoplasty limits the potential for donor antigen exposure to the immunocompetent cells in the anterior chamber, which is crucial in addition to minimizing the invasiveness of the procedure [1]. Deep membrane anterior lamellar keratoplasty (DALK) is a type of lamellar keratoplasty that rejoins the stroma to the Descemet's membrane in cases where the stroma might be in danger of loss [2]. In eyes with a healthy endothelium, DALK appears to be the best treatment for anterior corneal pathology, particularly in keratoconus, since it removes the chance of endothelial rejection, which could lead to graft failure [3]-[5]. Moreover, endothelial cell loss or rejection-related corneal endothelial failure is less likely when the host endothelium is preserved [6]. Additionally, because DM is preserved, it provides enhanced ocular structural integrity against blunt trauma [7] [8]. In recent years, deep anterior lamellar keratoplasty (DALK) has been used as a safer alternative to PK. DALK consists of replacement of the anterior portion of the recipient's cornea up to the posterior limit of the Descemet membrane (DM) with donor corneal tissue [9]. Using the DALK technique has fewer side effects than traditional penetrating keratoplasty (PK), which can cause retinal detachment, endophthalmitis, anterior synechiae, secondary glaucoma, and cystoid macular edema [10].

Since DALK is an extraocular surgical procedure, its benefits over PK include a lower risk of endophthalmitis, expulsive hemorrhage, and anterior chamber lesions [4]. Keratoconus is a degenerative, ectatic corneal disease characterized by progressive corneal steeping and protrusion, resulting in increasing regular and then irregular astigmatism. It can cause central or paracentral corneal thinning. End-stage conditions include corneal hydrops, corneal scarring, and loss of corrected distance visual acuity. There is still much to learn about the progressive disease's etiology and pathogenesis. The reported prevalence is 8.8 - 229 per 100,000, and the incidence varies from 1.3 to 25 per 100,000 annually, depending on the population [11] [12]. Due to vision impairment and/or intolerance to contact lenses and spectacles, patients with advanced Keratoconus require surgery. Poor visual acuity can be caused by altered corneal curvature, which can lead to irregular astigmatism and central corneal scarring. Restoring minimally irregular corneal clarity to allow for long term good vision is the goal of corneal transplantation [13]. Patients with progressive keratoconus have higher expectations for the outcome of their visual acuity and graft survival because they are generally younger [14]. Keratoconus patients are ideal candidates for DALK, as they are usually young and have good endothelium function [15].

## 2. Methods

### 2.1. Preoperative

Thirty keratoconic eyes from 30 patients had been operated on with deep anterior

lamellar keratoplasty.

## 2.2. Operative

Marking of the cornea center, partial thickness trephination of the cornea for a depth ranging from 450  $\mu\text{m}$  to 454  $\mu\text{m}$  using vacuum trephine. Using a blunt tipped spatula, a deep corneal pocket is initiated at the periphery of the trephine cornea. The DALK canula is introduced into the created pocket and passed into the deep corneal stroma, creating a tunnel till it reaches the corneal center. The air bubble is injected into the lamellar separation between the dual layer and corneal stroma; anterior chamber decompression through a paracentesis is done; and then the top layers of the cornea are removed using a crescent knife. Using a 15-degree knife, an incision was made in the most elevated anterior wall of the large bubble after applying some viscoelastic to the cornea's center. Then, viscoelastic was introduced into the space that had collapsed. To ensure the completion of the cleavage plane, a blunt spatula was introduced into the area.

Using blunt-tipped microscissors, the stromal layers were separated into four quadrants and removed.

Trypan blue was used to identify the donor corneal button's DM and endothelium, which were subsequently extracted using a dry swab or forceps. With sixteen interrupted 10-0 nylon sutures, the graft is fastened.

The patient was given topical eye drops containing 0.1% prednisolone acetate and 0.3% gatifloxacin. After full epithelialization, the antibiotic was stopped, and the steroid was tapered off over the course of two months. Patients were monitored on days 7, 14, and 28 following surgery, then every two weeks for 3 months.

## 2.3. Postoperative

After the first week, we began to receive partially reliable refractive data from the first follow-up visit, with the exception of a few patients who experienced a slight delay due to a persistent epithelial defect, which was appropriately managed. The second follow-up visit was 30 days, the third follow-up visit was 60 days, and the fourth follow-up visit was 90 days after surgery. UCVA and CDVA measurements, slit lamp examination, and corneal topography comprised the postoperative evaluation and data collection. Logarithmic scales were utilized to calculate the acuity improvement lines.

## 2.4. Statistical Analysis

Data were collected, tabulated, coded, and analyzed using SPSS 22 software (SPSS Inc., Chicago, Illinois, USA). The normality of the data was assessed by the Kolmogorov-Smirnov test. Non-parametric quantitative data was expressed as the median and interquartile range (IQR). A comparison between the variables of pre- and postoperative parameters of the samples was performed using the Wilcoxon test;  $P$  was considered significant at  $<0.05$ . Parametric continuous variables were expressed as the mean and standard deviation. The description of qualitative variables

was in the form of numbers and percentages. Results were presented as tabular & graphical forms.

## 2.5. Administrative Approval

The approval of the hospital director and head of the ophthalmology department was obtained before the study, and verbal consents of operated DALK cases were obtained after an explanation of the importance of the study.

## 3. Results

### 3.1. Preoperative Data

The study included 30 patients; the median age was 28.0 years; youngest patient was 17; and the eldest one was 57 years, with a range of 40 years and an interquartile range = 10.75. The mode was 24 years, and the standard deviation was 9.22 years, as shown in **Table 1**.

**Figure 1** shows that 53.33% of patients were females and 46.67% were males.

**Table 1.** Descriptive statistics of operated DALK patient's age in years.

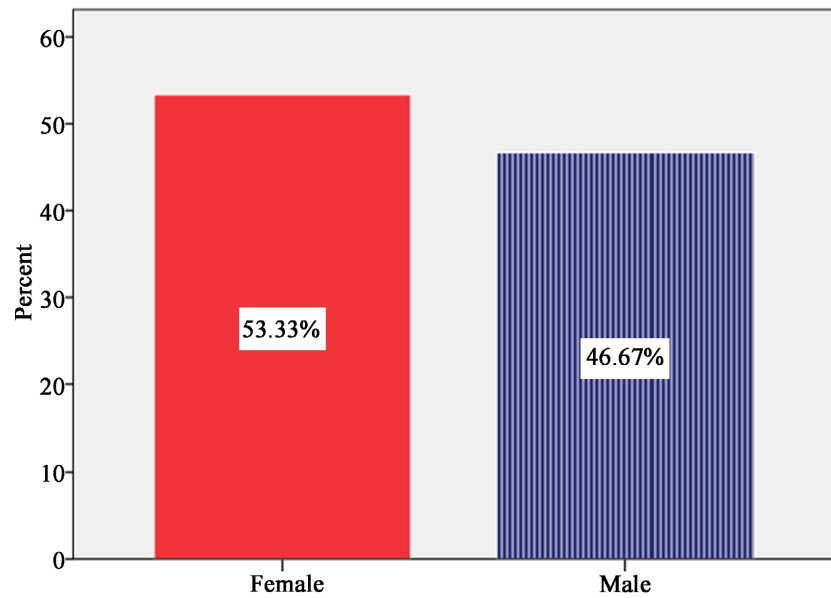
Descriptive statistics	Age in years
Minimum	17
Maximum	57
Range	40
Percentiles: 25	23.75
50	28.00
75	34.50
Mean	29.87
Median	28.00
Mode	24
Std. Deviation	9.22

### 3.2. Postoperative Data

Applying Wilcoxon Signed Ranks test, **Table 2** & **Table 3** show that both the pre-operative uncorrected visual acuity and best spectacles distance corrected visual acuity and their first week postoperative values illustrated statistical significant differences,  $P = 0.008$ .

Regarding; the pre-operative and the first week postoperative operative refractive cylinder values; were not statistically significant;  $P = 0.844$ . Spherical equivalent  $P = 0.742$ .

Applying Wilcoxon Signed Ranks test, **Table 4** shows that there was a statistical significant differences between both pre-operative uncorrected visual acuity and corrected distance visual acuity and their first month postoperative values,  $P = 0.004$  &  $0.001$  respectively.



**Figure 1.** Distribution of cases according to gender of operated DALK patients.

**Table 2.** Preoperative parameters of DALK patients.

Preoperative parameters	Values
K1	57.90 ± 9.59
K2	63.65 ± 9.79
Corneal cylinder	5.87 ± 2.66
K mean	60.62 ± 9.60
K max	72.97 ± 11.45
Thinnest corneal location	362.66 ± 49.24
Q-value	-1.89 ± 0.54
Uncorrected visual acuity	0.088 ± 0.04
Corrected distance visual acuity	0.09 ± 0.04
Spherical equivalent	-2.78 ± 1.37
Refractive cylinder	-5.63 ± 2.70

**Table 3.** Comparison between preoperative and first week postoperative parameters of operated DALK patients.

Parameters	Preoperative	Postoperative first week	P value
Uncorrected visual acuity	0.08 ± 0.04	0.15 ± 0.10	0.008
Corrected distance visual acuity	0.09 ± 0.04	0.15 ± 0.10	0.008
Spherical equivalent	-2.78 ± 1.37	-2.59 ± 2.72	0.742
Refractive cylinder	-5.63 ± 2.70	-5.19 ± 5.45	0.844

**Table 4.** Comparison between preoperative & first month postoperative parameters of operated DALK patients.

Parameters	Preoperative	Postoperative first month	P value
Uncorrected visual acuity	0.08 ± 0.04	0.34 ± 0.13	0.004
Corrected distant visual acuity	0.09 ± 0.04	0.34 ± 0.13	0.001
Spherical equivalent	-2.78 ± 1.37	-2.04 ± 2.07	0.114
Refractive cylinder	-5.63 ± 2.70	- 4.10 ± 4.16	0.114

**Table 5.** Comparison between preoperative and second month postoperative parameters of operated DALK patients.

Parameters	Preoperative	Postoperative two months	P value
Uncorrected visual acuity	0.08 ± 0.04	0.51 ± 0.11	0.004
Corrected distance visual acuity	0.09 ± 0.04	0.51 ± 0.11	0.001
Spherical equivalent	-2.78 ± 1.37	-1.76 ± 2.25	0.181
Refractive cylinder	-5.63 ± 2.70	-3.53 ± 4.51	0.200

Regarding, the pre-operative and first month postoperative spherical equivalent values, there were no statistically significant differences,  $P = 0.114$ . Similarly, the pre-operative and first month postoperative operative refractive cylinder values, they were not statistically significant,  $P = 0.114$ .

Applying Wilcoxon Signed Ranks test, **Table 5** shows that there was a statistical significant differences between both the pre-operative uncorrected visual acuity and corrected distance visual acuity and their second month postoperative values;  $P = 0.004$  &  $0.001$  respectively.

Regarding, the pre-operative and the second month postoperative spherical equivalent values, there were no statistically significant differences,  $P = 0.200$ . Similarly, the pre-operative and the second month postoperative operative refractive cylinder values, were not statistically significant,  $P = 0.114$ .

Applying Wilcoxon Signed Ranks test, **Table 6** shows that there was a statistical significant differences between both pre-operative uncorrected visual acuity and corrected distance visual acuity and their third month postoperative values,  $P = 0.004$  and  $0.001$  respectively.

Regarding, the pre-operative and the third month postoperative spherical equivalent values; there are statistically significant differences;  $P = 0.000$ . Similarly, the pre-operative and third month postoperative operative refractive cylinder values; were statistically significant;  $P = 0.000$ .

There were statistically significant differences between preoperative and postoperative K1, K2, and corneal cylinder measurements at the third month,  $P = 0.000$ ,  $0.000$  &  $0.021$  respectively.

There were statistically significant differences between the pre-operative K mean, K max and the thinnest corneal location and their third month postoperative values;

P = 0.000, 0.000 & 0.000 respectively.

Regarding; the pre-operative and the third month postoperative Q-value, there were no statistically significant differences; P = 0.289.

**Table 6.** Comparison between preoperative and third month postoperative parameters of operated DALK patients.

Parameters	Preoperative	Postoperative three months	P value
Uncorrected visual acuity	0.08 ± 0.04	63 ± 0.08	0.004
Corrected distance visual acuity	0.09 ± 0.04	76 ± 0.60	0.001
Spherical equivalent	-2.78 ± 1.37	-1.54 ± 1.13	0.000
Refractive cylinder	-5.63 ± 2.70	-3.08 ± 2.26	0.000
K1	57.90 ± 9.59	35.97 ± 4.76	0.000
K2	63.65 ± 9.79	44.30 ± 5.02	0.000
Corneal cylinder	5.87 ± 2.66	8.32 ± 4.73	0.021
K Mean	60.62 ± 9.60	39.56 ± 4.40	0.000
K Max	72.97 ± 11.45	51.24 ± 4.01	0.000
Thinnest corneal location	362.66 ± 49.24	518.86 ± 34.75	0.000
Q-Value	-1.89 ± 0.54	-1.57 ± 2.29	0.289

#### 4. Discussion

Deep anterior lamellar keratoplasty is regarded as a perfect approach in the treatment of keratoconus. In the present study, operated cases were followed up at 7, 30, 60, and 90 days, post-operative. There were significant improvements in post-operative compared to preoperative parameters in UCVA; CDVA at the first week were ( $P < 0.05$ ). Similarly, there were statistically improved postoperative compared to preoperative parameters in UCVA; CDVA at 30 and 60 days. At 90 days, there were statistically improved postoperative compared to preoperative parameters in UCVA, CDVA, spherical equivalent, refractive cylinder, K1, K2, corneal cylinder measurements, K mean, K max, corneal thinnest location, and the mean of (Q-value) corneal asphericity. Many studies showed similar results, as these studies demonstrated that there was reduction in corneal astigmatism. The reason for the apparent changes in the refraction and visual acuity of keratoconus patients could be the changes in the corneal surface [16]-[18]. This technique is considered one of the safest and most effective surgical choices in the treatment of keratoconus [19]. It is evident that the DALK technique could improve UCVA and CDVA in patients with anterior corneal pathology [20]. Furthermore, it is responsible for stable long-term visual and refractive outcomes with minimal complications compared to standard PK [3].

It is recommended that the use of DALK be safe and effective for keratoconus. Further studies on a higher number of cases are needed. The scant data that is

currently available supports improved visual results with PK but decreased rejection and refractive astigmatism with DALK. Internationally agreed-upon data sets and protocols for follow-up are necessary.

## Conflicts of Interest

The authors declare no conflicts of interest.

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