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Original article

Indications, Surgical Procedures, and Vision Outcomes of Keratoplasty at Tripoli Eye Hospital, Libya

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Abstract
Corneal transplantation is the most effective treatment modality for corneal blindness. All types of keratoplasty have a high success rate in restoring corneal clarity and visual rehabilitation of affected individuals. Corneal blindness represents the third most common cause globally. In contrast, a successful corneal graft can overcome the burden associated with corneal blindness. A study aimed to explore indications, types of keratoplasty, and vision outcomes at Tripoli Eye Hospital. This observational retrospective study was conducted on patients undergoing keratoplasty at Tripoli Eye Hospital from January 2021 to December 2022. 162 eyes of 162 patients underwent different types of keratoplasty. 162 eyes of the 162 patients were included in the current study, of which 88 (54.3%) were males and 74 (45.7%) were females. The mean age of the patients was (43.49 ± 21.48) years. The most common indications for keratoplasty were 80(49.3%) keratoconus, 41 (25.3%) decompensated cornea, 11 (6.8%) graft rejection, and 10 (6.1%) trauma. The most common type of surgery was PKP 63(38.8%), DALK 58 (35.8%), DMEK 28 (17.3%), and 13 (8.0%) Triple Procedure. The visual outcomes were the pre-operative keratoplasty; only 8(4.9%) eyes had a BCVA of 20/40 or better. In comparison, 28(17.2%) eyes had a BCVA ranging between 20/50 and 20/100, and the majority of eyes, 126(77.7%) had vision 20/200 or worse. In the postoperative keratoplasty, around 72(44.4%) experienced an improvement in BCVA to 20/40 or better, whereas 52(32.0%) eyes had a BCVA ranging between 20/50 and 20/100, and 38(23.4%) eyes had a vision from 20/200 or worse. After keratoplasty, our patients' main goal was to improve their quality of life through good vision outcomes. Patient education, preventive measures, and improvements in primary eye healthcare services are required to reduce the burden of cornea blindness.
Keywords. *Corneal Blindness, Indications, Keratoplasty, And Vision Outcome.*

Introduction

Corneal Blindness is one of the most significant public health challenges in developing nations. According to the last report by the World Health Organization, at least 2.2 billion people have near or distant vision impairment. At least 1 billion vision impairments could have been prevented or are yet to be addressed. The most common causes of blindness and visual impairment are refractive error, cataracts, glaucoma, diabetic retinopathy, and age-related macular degeneration. While corneal blindness is displaced, particularly after trachoma eradication intervention, antibiotics improve eye healthcare services [1]. Libya is a developing nation where corneal disorders are considered the leading cause of blindness among different age groups. According to the Rapid Assessment of Avoidable Blindness, the most common causes of blindness were cataracts (29%), glaucoma (24%), and other corneal scars (14%) [2].

Corneal Disorders are divided into infections, such as infectious keratitis and trachoma; nutritional disorders, such as vitamin A deficiency (xerophthalmia), and corneal dystrophies; trauma, such as corneal abrasion, penetrating trauma, and chemical injury; and iatrogenic pseudophakic bullous keratopathy and keratoconus. A practical and accessible healthcare service delivery system can tackle treatable or curable blindness. Many of those currently blind from corneal diseases can be visually rehabilitated by corneal transplantation. Keratoplasty is the most effective surgical procedure to improve vision and maintain the structural integrity of the eye. Approximately 50% of corneal blindness is treatable [3]. Keratoplasty (PKP) was performed for the first time in 1905, and Eduard Konrad Zirm performed the first corneal transplant using a solid organ. He accomplished the first full-thickness corneal transplant with success. A patient with bilateral alkali burns underwent surgery. The Russian ophthalmologist *Vladimir Petrovich Filatov* is the founder of keratoplasty since he first proposed using cadaveric corneas as donor corneas for keratoplasty procedures [4].

In 1813, K. Himly made a significant contribution to the field of corneal transplantation by proposing the concept of replacing a cloudy or opaque cornea from one animal with the cornea of another animal. This pioneering work in animal corneal transplantation established the foundation for future developments in corneal surgery and transplantation [5]. In 1824, F. Reisinger coined the term keratoplasty, and he was the first to suggest that the human cornea could be replaced by animal corneal tissue. SLL Bigger completed the first animal allograft transplant in 1837. Henry Power conducted his first corneal grafting experiment in 1872. Von Hippel coined the phrase "lamellar keratoplasty" in 1880 and was the first

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to create the circular trephine. In 1908, Plange first performed auto keratoplasty. VP Filatov made a substantial contribution to keratoplasty between 1910 and 1950; he carried out the first systematic investigation in the field [6].Additionally, he proposed using cadaveric corneas as donor corneas. Castroveijo created several devices for corneal microsurgery between 1930 and 1950. R Paton was the first person in the United States to create an eye bank in 1944. Paufique and Charleux introduced the concepts of limbal and eccentric grafts and lamellar keratoplasty in 1950. Cott carried out the transplantation for the first time using a cryopreserved cornea in 1954. In 1960, Maumenee rejected the idea of graft [6]. Troutman designed the surgical instrument and microscope in 1965 and 1968, respectively. Maurice developed the first specular microscope. B. McCarey and H. Kaufman created the first corneal storage medium in 1974, coinciding with the concept of storage media. Archila EA conducted DALK dissection with air bubble assistance in 1985. Melles carried out the posterior lamellar keratoplasty and DALK procedures in 1998. Mark Terry performed the first deep lamellar endothelial keratoplasty (DLEK) in 2001. Descemet's stripping automated endothelial keratoplasty (DSAEK) and Descemet's stripping endothelial keratoplasty (DSEK) were concepts put forth by Price and Gorovoy in 2006. Melles carried out the Descemet membrane endothelial keratoplasty (DMEK) for the first time in 2006 [7]. Therapeutic Keratoplasty divided into Full-thickness therapeutic keratoplasty where corneal graft is placed over the host cornea after removing the diseased portion, primarily eliminating the infection [8], Tectonic keratoplasty were the full-thickness corneal graft is placed over the host cornea to restore its tectonic integrity [9], Patch graft which can be full-thickness or lamellar, depending on the extent of the corneal tissue's involvement [10] and therapeutic deep anterior lamellar keratoplasty in which the diseased corneal portion is usually the anterior stromal tissue; hence, the deep anterior lamella is removed and replaced with a partial-thickness graft [11].

Keratoplasty indications include Therapeutic corneal transplantation, which may afford the removal of infected corneal tissue in eyes unresponsive to antimicrobial therapy [12], and optical keratoplasty improves vision. Important indications include bullous keratopathy, keratoconus, dystrophies, degenerations, and scarring [13], Cosmetic grafting may rarely be performed to improve the appearance of the eye, Infectious Keratitis which lead to Corneal perforation, descemetocele, corneoscleral abscess, mycobacterial keratitis, infectious crystalline keratopathy, herpes simplex keratitis, herpes zoster keratitis, non-resolving keratitis with maximal medical therapy[14] and Other indications as Neurotrophic keratitis, corneal melt due to thermal injury, Corneal perforation secondary to keratoconjunctivitis sicca, Neuroparalytic keratitis, Exposure keratopathy with corneal perforation, Persistent epithelial defect leading to perforation [15–19].

In Libya, the main indication for keratoplasty is keratoconus, which is the most common indication globally. However, the visual outcome is still undetermined post-keratoplasty due to the unavailability of the procedure in Libya for more than one decade; therefore, the purpose of this study is to determine the visual outcome post-keratoplasty. This study aims mainly to determine the visual outcomes of keratoplasty at Tripoli Eye Hospital. And secondary to explore the most common indications of keratoplasty, to explore the most common types of surgery, and to identify the most common post-surgical complications.

Methods

A retrospective observational study was conducted on 162 patients (162 eyes) who attended the corneal clinic from 2021 to 2022 at the Tripoli Eye Hospital. The inclusion criteria included participants who are Libyan, patients within an age group of 18 to 75 years old, while the exclusion criteria were non-Libyan patients and those under 18 or above 75 years old. Data was collected from patients through an instructed questionnaire that included socio-demographic information and past ocular history. This was followed by eye examinations, including visual acuity, slit-lamp examination (anterior and posterior segments), and corneal topography. Patients were divided into different types of keratoplasty procedures depending on their corneal status and medical condition. The surgery was performed using a complete aseptic technique. Post-surgery, the patient was seen for the first follow-up to examine the eye, check for corneal conditions, and perform a visual acuity assessment. All information will be kept confidential. Ethical approval was obtained from the Libyan Board of Medical Councilors. All research adhered to the tenets of the Declaration of Helsinki and was HIPAA compliant. The data was entered and analyzed using SPSS version-25 (Social Package of Statistical Software), where the mean and standard deviation for continuous variables, frequency and percentage for categorical variables, one-way ANOVA (Analysis of Variance) for more than two categorical variables, and the p-value was considered significant if < 0.05.

Results

One hundred sixty-two patients (162 eyes) were divided into 88 (54.3%) males and 74 (45.7%) females, with a mean age of 43.49 ± 21.48. Of the total 162 eyes, 76 (46.9.%) right eyes were operated, 86 (53.1%) left eyes were operated on, as shown in (Table 1) and (Figure 1).

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Table 1. Age & Sex

	Mean	Frequency
Age	43.49 ±21.48	
Sex 1. Male 2. Female		 88 (54.3%) 74 (45.7%)

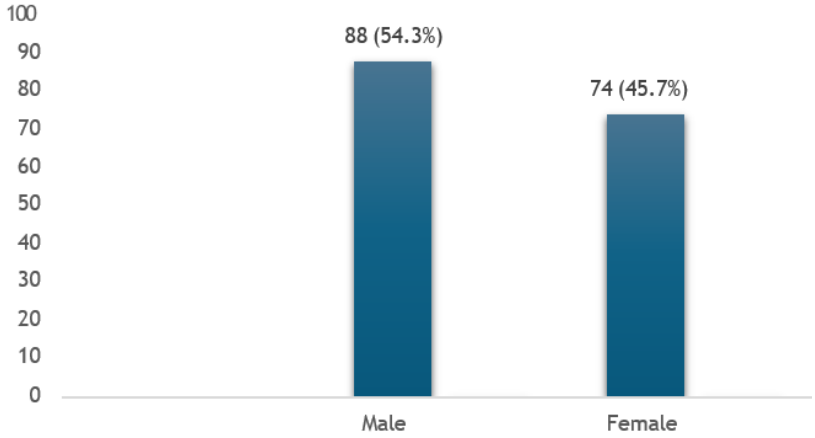

Figure 1. Sex (male & female)

The results reported for corneal diagnoses or indications of keratoplasty were 80 (49.3%) patients with keratoconus, 41(25.3%) patients with decompensated cornea, 11 (6.8%) patients with graft rejection, 10(6.1%) patients with trauma, 9(5.5%) patients with keratopathy, 7 (4.3%) patients with corneal dystrophy, and 4 (2.4%) patients with herpes, as shown in (Table 2) and (Figure 2).

Table 2. Indications of keratoplasty

Diagnosis	Frequency
KC	80 (49.3%)
Decompensated cornea	41(25.3%)
Graft rejection	11 (6.8%)
Trauma	10 (6.1%)
Keratopathy	9 (5.5%)
Corneal dystrophy	7(4.3%)
Patient with herpes	4 (2.4%)

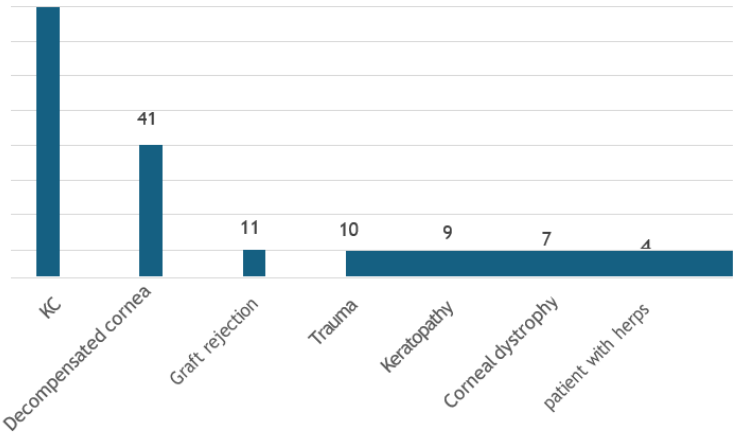

Figure 2. Indications of keratoplasty

The results reported for types of surgery were Penetrating Keratoplasty (PKP) 63(38.8%), DALK 58(35.8%), DMEK 28(17.3%) and triple Procedure 13 (8.0%), as shown in (Table 3) and (Figure 3).

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Table 3. Types of surgery

Types of surgery	Frequency (%)
PKP	63 (38.8%)
DALK	58 (35.8%)
DMEK	28 (17.3%)
Triple Procedure	13 (8.0%)

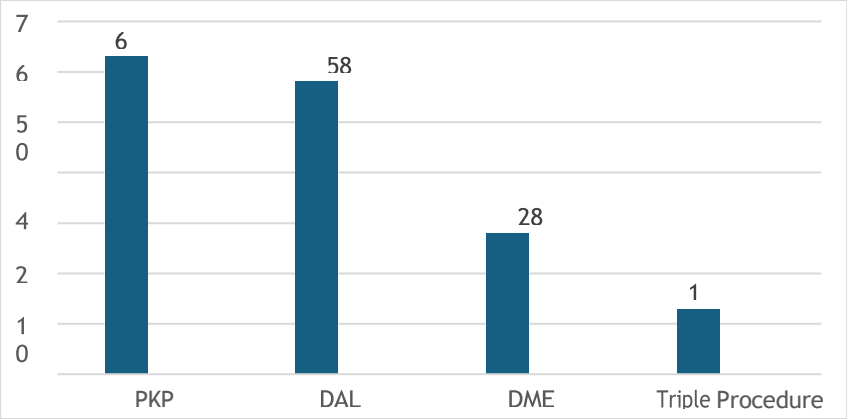

Figure 3 Types of Surgery

The results reported for postoperative complications were 99(63.0%) cases with no complications, 23(14.1%) cases with an epithelial defect, 19(11.7%) with resuture, 9 (5.5%) cases with exudative membrane, 5(3.08%) cases with endothelial defect, 4(2.4%) cases with graft rejection, 1(0.6%) case with iris prolapse, 1(0.6%) case with endophthalmitis, 1(0.6%) case with infection, as shown in (Table 4) and (Figure 4).

Table 4. Post-operative complications

Post ocular complications	Frequency (%)
No complication	99 (63.0%)
Epithelial defect	23 (14.1%)
Resuture	19 (11.7%)
Exudative membrane	9 (5.5%)
Endothelial defect	5 (3.08%)
Graft rejection	4 (2.4%)
Iris prolapse	1 (0.6%)
Endophthalmitis	1 (0.6%)
Infection	1 (0.6%)

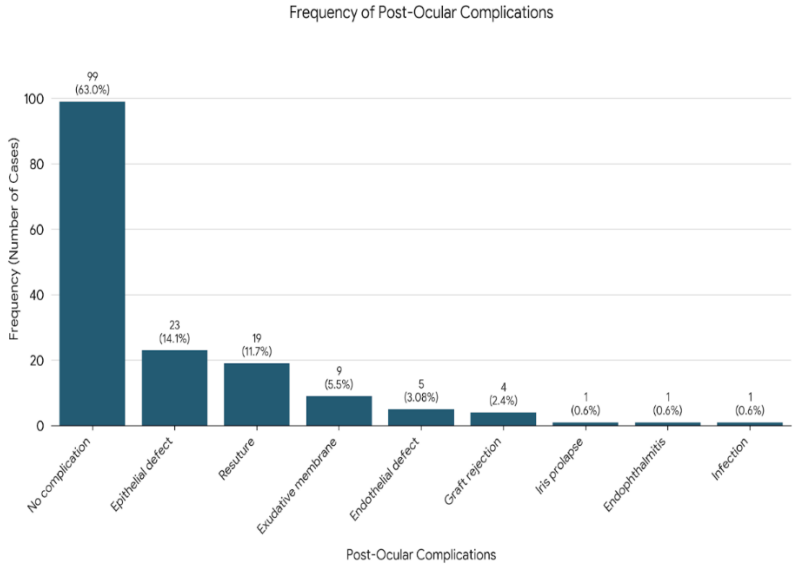

Figure 4. Post-operative complication

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The results reported for BCVA pre- and post-operative visual outcomes were the pre-operative keratoplasty; only 8(4.9%) eyes had a BCVA of 20/40 or better. In comparison, 28 (17.2%) eyes had a BCVA ranging between 20/50 and 20/100, and the majority of eyes, 126 (77.7%), had vision 20/200 or worse. In the postoperative keratoplasty, around 72(44.4%) experienced an improvement in BCVA to 20/40 or better, whereas 52(32.0%) eyes had a BCVA ranging between 20/50 and 20/100, and 38(23.4%) eyes had a vision from 20/200 or worse, as shown in Table 5. One-way ANOVA test of the BCVA pre- and post-operative visual outcome showed a ($p < 0.001$) indicating a significant improvement in visual outcome post keratoplasty.

Table 5. BCVAPre and post-visual acuity

Post-operative VA	**Pre-operative VA**			
	20/40 or better	20/50 thru 20/100	20/200 or worse	**Total**
20/40 or better	8	26	38	72
20/50 thru 20/100	0	2	50	52
20/200 or Worse,	0	0	38	38
Total	8	28	126	162

Discussion

Our study reported that the common indication for keratoplasty was keratoconus, followed by a decompensated cornea, rejected graft, diffuse corneal opacity, and corneal dystrophy. In a study conducted in Saudi Arabia, the leading indication for keratoplasty was keratoconus, accounting for nearly 53% of all keratoplasty procedures over six years [20]. In addition, other studies representing the percentage of keratoplasty due to keratoconus New Zealand (45.60%) [21], Iran (34.51%-42.5%) [22,23], Australia (29.8%) [24] France (28.80%) [25], UK (28.7%) [26], Zimbabwe (26.80%) [27], and Germany (20.90%) [28]. However, this is inconsistent with other regions where the percentage of keratoconus cases that require keratoplasty showed lower rates in reports from Brazil (13.10%) [29], China (13%) [30], Canada (12%-15.5%) [31,32], and the US (11.40%) [33]. In another study by Dr. May Saldanha, 60 patients underwent keratoplasty, and 30 had Pseudophakic bullous keratopathy as the indication.

Most patients had a significant visual acuity improvement during the one-week post-operative period. Fourteen patients' vision deteriorated over time due to improper medication usage and poor hygiene. Ten patients were lost to follow-up [34]. Jun Yi Wang et al. concluded that Infectious keratitis remained the leading indication for penetrating keratoplasty in Shandong, and fungal infections were still the primary cause of corneal infections [35]. In Vietnam, infectious keratitis is the most frequent reason for keratoplasty, consistent with reports of causes from other developing nations. Between 2005 and 2010, the most common reasons for corneal transplantation in Shandong, China, were infectious keratitis (37.1%), herpes simplex keratitis (19.1%), and keratoconus (11.2%) [36]. The most common indication in our study was keratoconus. The second most common cause for PK in this study was decompensated cornea, caused by most commonly caused by conditions such as Fuchs endothelial dystrophy or surgical trauma [37].

In our study, the most common type of surgery was penetrating keratoplasty, 63 (38.8%) followed by DALK 58 (35.8%). However, in India, the most common surgical procedure was full-thickness keratoplasty 1747 (74%) from 2011 to 2020 [38]. While in the United States, PK (decreased from 2015 to 2020 (19,160-15,402, 40% to 36.4%), while the DMEK procedure increased (9.8%-27.8%) [39]. In our study, the restored visual acuity after surgery was a tremendous improvement. We then obtained the goal of surgery. Meanwhile, a study in Saudi Arabia had the same successful visual outcome post-keratoplasty compared to pre-keratoplasty [40]. This study provided a snapshot of the prevalence, common keratoplasty indications, and visual outcomes in Libya compared to other studies, which reinforced similar results from other countries. The limitations of this study are that the duration of data collection was a year, compared to the average of 5 years in other studies, and that information was missing from the patient file. The strengths of the study are a representative sample size, different age groups, a low risk of postoperative complications, and a good visual outcome. Recommendations of this study are increasing awareness about corneal diseases, providing eye care, especially in rural areas, improving patient file documentation, and establishing corneal bank.

Conclusion

The study concluded that the visual outcome post-keratoplasty was improved, with minor ocular complications, which determined the success rate of keratoplasty. In addition, the main cause of keratoplasty was keratoconus. Improving the visual outcome leads to improved quality of life for the patient, which leads to the flourishing of the healthcare system and economy. Keratoplasty is becoming a less common surgery compared to the past decades, and types of keratoplasty allow avoiding full-thickness keratoplasty, which means a decrease in the risk of graft failure or graft rejection.

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