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Indications and Visual Outcomes of Corneal Transplant Surgery in Tanzania

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Abstract

Background: Corneal diseases are among the major causes of visual impairment and blindness worldwide, after cataract and glaucoma. They account for approximately 7% of all blindness worldwide. Corneal transplantation, an operation that replaces diseased corneal tissue with a healthy donor cornea, is increasingly in demand. Current information on corneal transplant indications, outcomes, and associated factors is crucial for planning corneal transplant services in resource-limited settings like Tanzania.

Aim: To determine the indications, visual outcomes, and associated factors among patients who underwent corneal transplant at tertiary eye units in Tanzania.

Methods: A hospital-based retrospective review and analysis of clinical records of all patients who underwent corneal transplant between January 2018 and September 2021 at Dr. Agarwals Eye Hospital and Kilimanjaro Christian Medical Centre. The data was extracted by a data collection tool from the case notes. Descriptive and logistic regression analyses were conducted using Statistical Package for Social Sciences version 23.

Results: Out of 98 patients who had undergone corneal transplant at the two eye departments, 58% were males. The median recipient age was 22 (IQR 17, 38) years. Keratoconus was the most common indication 58 (54.7%), followed by central corneal scar 19 (17.9%), and bullous keratopathy 10(9.4%). Preoperatively, 77.4% of eyes were blind, and none had normal vision. Postoperatively, 44.3% achieved normal best corrected vision at 6 months post-transplant. Patients with keratoconus (aOR: 0.032, 95% CI: 0.058-0.945, p = 0.035) and participants aged ≤ 40 years (aOR: 0.019, 95% CI: 0.001-0.452, p=0.014) were less likely to have poor visual outcome while presence of postoperative complications (aOR: 3.632, 95% CI: 1.107-11.915, P = 0.033) and postoperative increased intraocular pressure (aOR: 1.193, 95% CI 0.294-0.848, p = 0.025) were associated with poor visual outcomes.

Conclusion and recommendation: Keratoconus is the leading indication for corneal transplant. Vision improved significantly following corneal transplantation; however, postoperative complications and increased intraocular pressure were associated with poor visual outcomes. There is a need to establish more corneal transplant services, as they have shown satisfactory outcomes in our setting.

Key Words: *Corneal transplant, Penetrating Keratoplasty, Indications, Visual outcome.*

Introduction

Corneal transplantation (keratoplasty) involves the surgical replacement of diseased corneal tissue with a healthy donor cornea, primarily to improve vision, with additional benefits of pain relief and preservation of the eye (1). The global survey of corneal transplantation and eye banking report shows that Tanzania is among the few African countries that perform corneal transplantation (2).

According to the WHO, corneal diseases remain a major cause of blindness in developing countries (3). They account for approximately 7% of global blindness, and up to 25% of blindness in Africa (1,4). Despite a significant number of patients with curable corneal blindness, it is estimated that there is only one cornea available for every seventy people that need it (5). Corneal transplant services in Tanzania are inadequate, hampered by a lack of corneal banking facilities and the shortage of trained corneal transplant surgeons. Currently, all corneal tissues used in Tanzania are imported.

Indications for corneal transplant vary by regions, reflecting the occurrence of specific corneal diseases (6). The most common indications in developed countries are bullous keratopathy and keratoconus, whereas in developing countries, infective keratitis and corneal scars predominate (7). The outcome of a corneal transplant depends on preoperative factors, surgical techniques, and postoperative complications (8). While developed countries report good visual outcomes in 80–100% of cases, only a minority of patients in developing countries achieve best corrected vision above 6/18 (2,7).

Given the limited availability of donor corneas and the shortage of skilled personnel in resource-limited settings, it is important to understand the indications for corneal transplantation and the relationship between the visual outcome and associated factors. Furthermore, understanding the visual outcomes of corneal transplantation will help provide evidence to support or modify current practices in patient selection and management, thereby maximizing graft survival and achieving better visual outcomes (8). Therefore, this study aimed to assess the indications and visual outcomes of corneal transplant and its associated factors among patients who underwent corneal transplant surgery at Dr. Agarwals Eye Hospital and Kilimanjaro Christian Medical Centre (KCMC) in Tanzania.

Material and Methods

Study design, period, and area

A hospital-based retrospective review and analysis of patients' clinical records who underwent corneal transplant at two tertiary eye units from January 2018 to September 2021. Data were collected from October to December 2021 at two tertiary eye units of Dr. Agarwals Eye Hospital and KCMC in Tanzania.

Dr. Agarwals Eye Hospital is a private hospital located in Dar es Salaam. It serves patients from various regions of the country as well as from neighbouring countries. The hospital attends to approximately 21,000 patients annually, of whom about 600 have corneal diseases. The eye department at KCMC is the main referral site for ophthalmic cases from northeastern Tanzania. Approximately 39,000 patients seek eye care at the department annually.

Population, Inclusion, and Exclusion Criteria

Clinical records of patients who underwent corneal transplant surgeries within the study period and who had completed a minimum of 6 months of follow-up were included in the study. Records with incomplete patient data were excluded from the study. A minimum follow-up of 6 months was chosen because it is reported that although vision is good immediately after corneal transplantation, best vision is achieved 6 months to 1 year later.

Sample size calculation and Sampling Technique

The minimum sample size (N) was calculated by using the modified Cochran formula for adjusting for a finite population, as shown below:

Adjusting for a finite population:

$$n = \frac{n_0}{1 + \frac{n_0 - 1}{N}} \qquad n = \frac{339.166}{1 + \frac{339.166 - 1}{106}}$$

n = 80.93

The minimum sample size required is 81 eyes.

Where;

n_0 = minimum sample size required in an infinite population, Z =1.96 for 95% confidence level, P= 32.9% (proportion of patients with good visual outcome (visual acuity of ≥ 6/18) based on a study done in Kenya by Chen MC. et al (9). Corneal transplantation: Analysis of outcomes and associated patient socioeconomic characteristics, ε = margin of error, which is 5%, n = actual final sample size, N = number of surgeries done (eyes).

A consecutive non-probability sampling technique was deployed whereby clinical records of all patients who underwent corneal transplant and met the inclusion criteria were consecutively included in the study.

Data Collection

Data were collected through a review of patient records from the respective hospitals. Information extracted from the clinical records included demographic characteristics such as age, gender, and residence. Other information included the date of surgery, preoperative clinical diagnosis, history of previous surgery on the same eye, donor details, time from harvest to transplant, and the presence of ocular comorbidities like cataract and glaucoma. The type of corneal transplant surgery performed was recorded, noting whether it was done alone or in combination with other procedures during the same session. Information on postoperative complications and the date of the last follow-up visit was also documented. Preoperative, one-month, three-month, and six-month postoperative visual acuities measured using the Snellen chart were recorded to assess visual outcomes. The preoperative, one-month, and three-month postoperative best corrected visual acuities (BCVA) were measured using a pinhole, while the six-month postoperative BCVA was assessed after refraction. The BCVA for the operated eye was categorized as follows: ≥ 6/18 as normal vision, <6/18 – 6/60 as moderate visual impairment, <6/60 – 3/60 as severe visual impairment, and <3/60 as blindness. A BCVA of ≥ 6/18 in the operated eye was considered a good visual outcome, while a BCVA of <6/18 was regarded as a poor visual outcome. Each patient's record was first

documented manually on a data sheet and then entered into software for analysis.

Data Management and Analysis

Data entry and analysis were performed using the Statistical Package of Social Sciences (SPSS) version 23. The description of demographic and clinical data of patients who underwent corneal transplant was done through frequencies and percentages. Univariable and multivariable logistic regression models were employed to assess the association between each associated factor and the visual outcome. The P-value of <0.05 was considered statistically significant. The main outcome measures were the visual outcome and its associated factors.

Ethical Considerations

This study was ethically approved by the Institutional Review Board (IRB) of MUHAS (MUHAS-REC-09-2021-844). Permission to conduct the study was sought from the relevant hospital authorities. The data was stored safely and used for the study. This study did not harm the participants or any other people who, in one way or another, were involved in the study.

Results

A total of 106 eyes of 98 patients were recruited and included in the analysis. Eight (8.2%) patients had keratoplasty done in both eyes. There were more males, 57 (58.2%). The majority, 75 (76.5%), were aged ≤ 40 years with a median age of 22 (IQR: 17, 38) years. Penetrating keratoplasty was the predominant technique (84.9%). Keratoplasty combined with other intraocular surgeries was performed in 12.3% of eyes. The most common procedure done concurrently with keratoplasty was cataract surgery. Glaucoma was present in 12 (11.3%) eyes (Table 1)

Table 1: Demographic and clinical characteristics of participants and participants' eyes

Characteristics	Frequency n	%
Age groups (years)		
≤40	75	76.5
>40	23	23.5
Median age 22 (IQR: 17, 38) years		
Sex		
Male	57	58.2
Female	41	41.8
Type of keratoplasty		
Penetrating keratoplasty	90	84.9
DALK	16	15.1
Combined surgery		
Yes	13	12.3
No	93	87.7
Type of combined surgery		
Keratoplasty + Cataract surgery	8	61.5
Keratoplasty + Pupilloplasty	3	23.1
Keratoplasty + Secondary IOL	1	7.7
Keratoplasty + IOL exchange	1	7.7
History of previous surgery on the same eye		

Yes	25	23.6
No	81	76.4
Type of previous surgery done*		
Cataract surgery	11	42.3
Penetrating keratoplasty	7	26.9
RRD surgery	3	11.5
Cornea repair	3	11.5
Collagen cross linking	2	7.8
Glaucoma		
Yes	12	11.3
No	94	88.7

***One eye had both cataract surgery and previous penetrating keratoplasty. DALK = Deep anterior lamellar keratoplasty, RRD = rhegmatogenous retinal detachment.*

Keratoconus was the most common indication, followed by corneal scarring. The majority of eyes with keratoconus were in patients aged 40 years or less (Table 2).

Table 2: Indications for corneal transplant by age (N = 106 eyes)

	Age groups (years)		Total
Indications	**≤ 40**	>40	
	n (%)	**n (%)**	**n (%)**
Optical			
Keratoconus	57 (98.3)	1 (1.7)	58 (54.7)
Central corneal scar	14 (73.7)	5 (26.3)	19 (18)
Bullous keratopathy	2 (20)	8 (80)	10 (9.4)
Failed graft	3 (42.9)	4 (57.1)	7 (6.6)
Corneal dystrophy	4 (80)	1(20)	5 (4.7)
Keratoglobus	1 (33.3)	2 (66.7)	3 (2.83)
Therapeutic			
Advanced keratitis	1 (33.3)	2 (66.7)	3 (2.83)
Tectonic			
Corneal perforation	0 (0)	1 (100)	1 (0.94)
Total	**82**	**24**	**106 (100)**

Preoperatively, 77.4% of eyes were blind, and none had normal vision. There was a statistically significant improvement in BCVA 6 months postoperatively (p = 0.023) (Table 3). Forty-seven (44.3%) eyes achieved a good visual outcome with BCVA of ≥ 6/18 six months postoperatively (Figure 1).

Loose suture was the commonest complication, followed by increased intraocular pressure (Table 4).

Table 3: Preoperative and 6-month postoperative best corrected visual acuity of patients' eyes (N = 106 eyes)

Visual acuity	Preoperative n (%)	6 months postoperative n (%)	P value (Chi-square test)
6/6 – 6/18 (Normal)	0 (0)	47 (44.3)	0.023
<6/18 – 6/60 (MVI)	18 (17.0)	26 (25.5)	
<6/60 – 3/60 (Severe VI)	6 (5.7)	2 (1.9)	
<3/60 (Blindness)	82 (77.3)	31 (29.3)	

VI = Visual impairment, MVI=moderate visual impairment

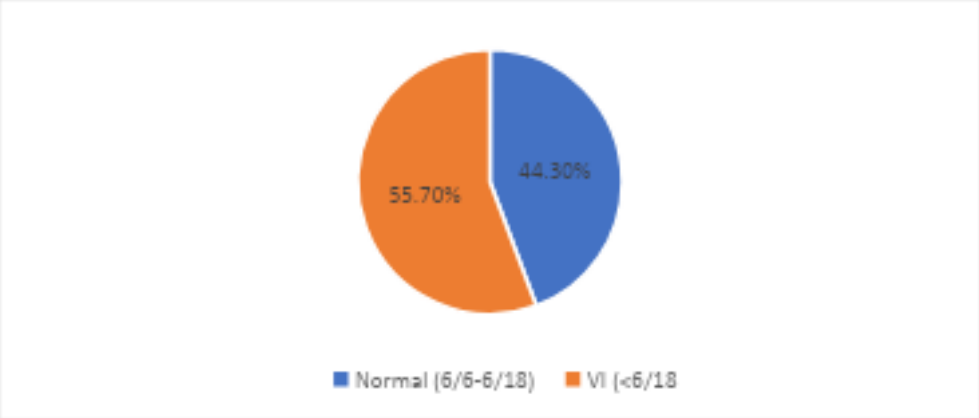

Figure 1. Six months post corneal transplant visual outcome (N =106)

Table 4: Post corneal transplant complications

Complications	Frequency n	%
Yes	40	37.7
No	66	62.3
Total	**106**	**100**
Loose sutures	36	30.2
Increased intraocular pressure	31	26.1
Bacterial Keratitis	19	16.0
Graft Failure	12	10.1
Graft Rejection	8	6.7
Wound Dehiscence	4	3.4
Others*	9	7.6
Total	**119**	**100**

32 eyes had more than one complication. *Corneal Neovascularization (4), Retinal detachment (1), Uveitis (3), Endophthalmitis (1).

Younger age ≤ 40 years (aOR: 0.019, 95% CI: 0.001-0.452, p = 0.014) and Keratoconus (aOR: 0.032, 95% CI: 0.058-0.945, p = 0.035) were less likely to have a poor visual outcome. Those who had post-operative complications were 3.632 times likely to have a poor visual outcome (95% CI: 1.107-11.915, P = 0.033), and post-operative increased IOP had a 1.193 times likelihood of having a poor visual outcome (95% CI: 0.294-0.848, P = 0.025) (Table 5).

Table 5: Logistic regression analysis of factors associated with poor visual outcome

Variables	Bivariable Analysis			Multivariable Analysis		
	cOR	95%CI	p-value	aOR	95%CI	p-value
Age group						
≤40	0.034	0.040-0.204	0.001	0.019	0.001-0.452	0.014
>40	Ref			Ref		
Diagnosis						
Keratoconus	0.106	0.026-0.408	0.001	0.032	0.058-0.945	0.035
Corneal scar	0.525	0.106-2.603	0.430	1.307	0.140-10.153	0.814
Bullous keratopathy	0.750	0.104- 5.434	0.750	0.112	0.105-2.389	0.161
Others*	Ref					
Type of surgery						
Penetrating keratoplasty	0.303	0.097-0.946	0.040	3.522	0.803-15.447	0.095
DALK	Ref					
Previous surgery						
Yes	0.232	0.079-0.679	0.008	0.336	0.044-2.557	0.292
No	Ref			Ref		
Combined surgery						
Yes	0.085	0.011-0.682	0.02	1.662	0.085-32.648	0.738
No	Ref			Ref		
Glaucoma						
Yes	10.542	1.308-84.946	0.027	9.014	0.410-98.181	0.163
No	Ref			Ref		
Post-op complication						
Yes	3.333	1.469-7.565	0.004	3.632	1.107-11.915	0.037
No	Ref			Ref		
Graft rejection						
Yes	0.161	0.019-1.362	0.094	8.207	0.425-158.592	0.164
No	Ref			Ref		
Post-op increased IOP						
Yes	0.398	0.162-0.978	0.045	1.193	0.294-0.848	0.025
No	Ref			Ref		
Post-op bacterial keratitis						
Yes	0.518	0.180-1.487	0.221	-	-	-
No	Ref					
Wound dehiscence						
Yes	0.406	0.041-4.033	0.441	-	-	-
No	Ref					

*Key: cOR: Crude Odds ratio, aOR: Adjusted Odds ratio, Ref: Reference category, post-op: post-operative, IOP: Intraocular pressure. *Failed graft, corneal dystrophy, Keratoglobus, advanced keratitis, and corneal perforation.*

Discussion

We aimed to analyze the indications, visual outcomes, and associated factors among patients who underwent corneal transplantation. Penetrating keratoplasty was the most common technique of corneal transplant (84.9%), a finding comparable to reports by Zare et al. (78.2%) in Tehran and Jamal et al. (68.7%) in Iran (10,11). In the current study, the leading indication for corneal transplant was keratoconus (54.7%), followed by central corneal scar (17.9%) and bullous keratopathy (9.4%). Keratoconus, bullous keratopathy, and corneal scar have also been reported as major indications in previous studies from Nigeria (Umana et al.), Iran (Zare et al.), Ghana (Lartey et al.), and Kenya (Chen et al.), irrespective of the order (5,9–12).

Although we couldn't find data on the exact prevalence of keratoconus in Tanzania, these results suggest that the condition may be relatively common in this setting. Keratoconus is a common corneal complication of vernal keratoconjunctivitis, which is reported to be prevalent in sub-Saharan Africa (13,14).

Central corneal scarring was identified as a significant indication in the current study, with most of these cases resulting from avoidable causes such as infective corneal ulcer and ocular trauma. These findings indicate that corneal scarring remains an important cause of ocular morbidity in our setting, despite global initiatives aimed at eliminating corneal blindness by addressing its underlying causes. Effort is needed to ensure the availability of preventive measures and proper treatment of these corneal diseases.

Bullous keratopathy, primarily caused by pseudophakia, ranked as the third indication. The increasing number of cataract surgeries may contribute to this trend, as damage to endothelial cells during cataract surgery with or without intraocular lens implantation can lead to bullous keratopathy (15). It is important to assess corneal endothelial cell density in high-risk patients before cataract surgery to minimize endothelial cell damage and thereby reduce the risk of developing bullous keratopathy. In addition, cataract surgery in patients with low corneal endothelial cell counts should be performed by experienced surgeons. Findings from this study showed that 82 (77.4%) eyes were blind preoperatively, with a BCVA of <3/60, which decreased to 31 (29.3%) eyes 6 months postoperatively. A good visual outcome (BCVA ≥6/18) was achieved in 44.3% of recipient eyes at 6 months after surgery. This improvement in visual acuity is comparable to findings from developed countries such as Sweden (Claesson et al.), the United Kingdom (Brahma et al.), and Australia (Williams et al.), which reported normal vision in 54%, 48% and 52% of eyes, respectively (8,16,17). However, the proportion of eyes with normal vision postoperatively in the current study was higher than that reported in other studies conducted in African settings (5,9,18). These disparities may be attributed to differences in patient profiles, duration of follow-up, and the cutoff points used to define visual outcomes.

The predominant postoperative complications were loose sutures in 36 (34%) eyes and

increased intraocular pressure in 31 (29.2%) eyes. Loose suture has also been reported as a frequent postoperative complication in Ghana by Lartey et al. (12). Increased IOP was also a common complication in studies reported in Ghana by Lartey et al. (22.7%), in Ethiopia by Ayalew et al. (30%), and in Poland by Szkodny et al. (13.06%) (12,18,19). Inflammation, vitreous in the anterior chamber angle, retained viscoelastic, iritis, and long-term use of topical steroid drops are some of the reported possible causes of increased IOP after corneal transplant surgery (20).

Endophthalmitis, a rare but devastating postoperative complication, occurred in 1 (0.9%) eye in the current study. It has also been reported in Ethiopia (7%) by Ayalew et al., Poland (0.88%) by Szkodny et al., and Egypt (4 %) by Alsherbiny et al. (18,19,21). Although we could not identify specific risk factors for endophthalmitis in our study, it remains essential to adhere to standard surgical protocols and properly manage recognized recipient risk factors to minimize the risk of this complication. The eye was eviscerated after the failure of antibiotic treatment.

Our study found that the majority of eyes with keratoconus (63.8%) achieved a good visual outcome compared to other indications (p = 0.001), consistent with findings from other studies (21,22). Furthermore, keratoconus was less likely than other indications to have a poor visual outcome (aOR: 0.032, 95% CI: 0.058-0.945, p = 0.035). The better visual outcomes observed in patients with keratoconus may be attributed to the low prevalence of other ocular pathologies in these eyes, as keratoplasty for keratoconus is usually performed in younger patients. In the present study, 98.3% of eyes with keratoconus belonged to patients aged ≤ 40 years. This finding offers valuable guidance for counselling our patients, allowing them to have more realistic expectations based on their specific indications for corneal transplant.

In the current study, participants aged ≤ 40 years were less likely to experience poor visual outcomes (aOR: 0.019, 95% CI: 0.001-0.452, p = 0.014) compared to those over 40 years. Older patients are more likely to have ocular comorbidities, such as glaucoma and retinal changes, which can negatively affect vision; this was evident in the present study, where the majority of eyes with glaucoma belonged to patients aged over 40 years.

Eyes with postoperative complications were 3.632 times more likely to have poor visual outcomes compared to those without complications (95% CI: 1.107-11.915, p = 0.033). Among these complications, postoperative elevated IOP was significantly associated with poor visual outcomes, with affected eyes having 1.193 times the likelihood of a poor visual outcome (CI: 0.294-0.848, p = 0.014). This finding is comparable to reports from other studies (12,18). Elevated IOP following corneal transplant can lead to endothelial cell loss and endothelial dysfunction, potentially resulting in graft failure and reduced vision (20).

This study was limited by its retrospective design. Some of the key factors, such as donor tissue details, were missing from most patient records and were therefore excluded from the analysis. Assessing the severity of ocular comorbidities that can also affect vision, such as glaucoma, was also challenging due to limited documentation. A prospective study would be more effective in evaluating the impact of these factors.

Conclusion

Keratoconus was the predominant indication for cornea transplant, followed by central corneal scar and bullous keratopathy. A significant proportion of eyes showed visual improvement after surgery. Keratoconus was associated with good vision postoperatively, whereas postoperative complications and postoperative elevated IOP were significantly linked to poor visual outcomes.

Recommendations

The promising visual outcomes following corneal transplant surgery should encourage the government and other health stakeholders to establish more affordable and accessible corneal transplant centers in Tanzania.

Competing interest

There are no competing interests to declare.

Author contributions

Concept and design (ZMS, CM, PN, and SM), data collection and analysis (ZMS), drafting manuscript (ZMS, CM), critical revision of manuscript (CM, SM, KD, and EM). All authors reviewed and approved the manuscript.

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