Outcome of penetrating Keratoplasties performed at Kikuyu Eye Unit from 1993 to 2003.

A dissertation submitted as part fulfillment

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By

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DECLARATION

This dissertation is my original work, and has not been presented for a degree at any

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Dedication

To my wife Diana and daughter Sampa and the Lord Jesus Christ,

our hope.

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LIST OF ABBREVIATIONS

ABK...Aphakic bullous keratopathy

AC..Anterior chamber.

BD..Twice daily

CI..Confidence interval

CNS..Central nervous system.

ECCE...Extracapsular cataract extraction.

HIV.. .....Human immunodeficiency virus.

HSV..Herpes simplex virus.

IOL...Intraocular lens power.

IOP...Intraocular pressure.

KC...Keratoconus.

KEU..Kikuyu Eye Unit.

MU..Mooren`s ulcer.

NKC..Non- keratoconus

NPL...No perception of light.

OR...Odds Ratio.

PBK...Pseudophakic bullous keratopathy.

PC.. .....Posterior chamber.

PED...Persistent epithelial defects.

PKP...Penetrating keratoplasty.

QID...Four times daily.

RD...Retinal detachment.

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Abstract

Aim: The major objective of the study was to establish long and short term survival rates and visual outcome of corneal grafts performed at KEU between 1993 and 2003. Other objectives included the establishment of indications, postoperative complications and associations with graft survival of donor age, endothelial count, cadaveric time and storage time of donor tissue used for PKP.

Methods: A retrospective study of 227 grafted eyes of 223 patients, grafted between 1993 and 2003 was conducted at KEU.

Results: Sixty percent of eyes were grafted for KC, four of whom had PKP in both eyes. The highest proportion of NKC indications included PBK (7.5%), trauma (6.6%) and dystrophies (5.3%). There was no significant difference in follow up between KC (5.25 years) and NKC (4.55 years) patients (p = 0.117). KC patients were generally younger than NKC patients (p < 0.001). The commonest immediate complications were uveitis, PEP and primary failures. There were 11 primary and 15 secondary failures accounting for 35.1% of all failures. Apart from primary and secondary failure, infections were more likely to cause graft failure compared to other complications (p<0.001). Grafted NKC eyes were more likely to fail compared with KC eyes (p < 0.001). A total of 74 eyes failed of which 36 were NKC eyes accounting for 40.4% of all NKC eyes. The highest risk for failure was seen in eyes with HSV (p = 0.025; OR = 4.44), and trachoma (p = 0.009; OR = 6.66). At 2 years, the probability of survival for KC was 81.1% (95%CI, 74.7 – 87.4%) while that for NKC was 71.3% (95%CI, 60.1 – 81.9%).

The probability of survival for KC was 76.3% (95%CI, 70.1 – 82%) at 5 years and 72.3% (95%CI. 66.4 – 77.7%) at 10 years. For NKC cases, the probabilities of survival were even lower at 65.3% (95%CI, 55.6 – 75.8%) at 5 years and 57% (95%CI, 48.6 – 66.1%) at 10 years. There was no association between graft survival in both KC and NKC groups and endothelial count, age of donor, and storage time (p = 0.73, 0.119 and 0.067 respectively). There was however an association between graft survival and cadaveric time (p = 0.012). In KC eyes, graft failure increased with increasing cadaveric time (p = 0.007). Postoperatively, KC eyes were more likely to have best corrected visual acuity of 6/18 and better (p=0.003).In total 93 (41.7%) patients were blind preoperatively. After surgery only 26 (11.7%) of all the patients remained blind. There was therefore a 72% reduction in blindness amongst all the patients who were blind preoperatively. Only 6 KC patients remained blind after PKP out of 60 patients who were blind pre-operatively, while 20 out of 33 NKC patients remained blind after PKP. There was minimal impact on blindness among the NKC patients.

Conclusions: Penetrating Keratoplasty can be successful in our setting especially for KC, PBK and corneal dystrophies. There is very little role for PKP in our setting for major causes of corneal blindness like trachoma, and vitamin A deficiency. Increasing donor age and associated lower endothelial counts, and longer storage times associated with transporting donated corneas over long distances do not affect graft outcome in terms of survival. However increasing cadaveric time would lead to an increase in the number of graft failures.

1.0.0 Introduction.

Over the past 30 years, penetrating keratoplasty (PKP) has become the most frequently performed method of corneal transplantation in the developed world.[1] The relative success of PKP is attributable to the continued advance in surgical techniques, equipment, ocular pharmacology and immunology, corneal storage and eye banking procedures.[2]

In Africa, few centers are providing this service despite corneal disease being one of the leading causes of blindness. There is therefore very little information on outcome of PKP in our setting .The study carried out in Kenya by Yorston et al assessed the 2 year survival rates and impact on blindness of PKPs performed at KEU before 1993.This study aimed at looking at both long term (at least 5 years) and short term outcome of PKP performed at Kikuyu Eye unit from 1993 to 2003 inclusively.

1.1.0 Epidemiology.

In the developed world, corneal blindness accounts for 2% of blind registration while in the developing world 25% of blindness is as a result of corneal disease.[1] In some areas of Africa however, corneal blindness accounts for as much as 90% of blindness.[23]

Fourty to 70% of childhood blindness is Africa is as a result of corneal causes.[11] A study of eye diseases in West bank and Gaza done by Thomson and Chambley found a prevalence of binocular blindness of 1.7%, with corneal pathology accounting for 25.2%.[6] This figure has been reported in many places of the third world. The commonest pathologies include vitamin A deficiency, measles and trachoma.[1,2,11] Literature search reviewed no published studies showing prevalence of keratoconus in Africa.

2.0.0 Literature Review.

Keratoplasty is a surgical procedure in which abnormal corneal host tissue is replaced by health donor corneal tissue. The graft could either be full thickness (PKP) or partial thickness (lamellar or deep lamellar).[9] In this study only the outcome of PKP was considered.

2.1.0 Indications.

Indications for PKP vary from developed to developing nations. An earlier study done by Yorston et al, at Kikuyu Eye unit, looking at the 2 year outcome of the grafts performed at this institution before 1993, showed that 50% of PKP were carried out for KC while trachoma, measles and bacterial keratitis accounted for 7% of the total indications. Other indications were corneal scar 11%, herpes simplex keratitis 7.9%, corneal dystrophy 7.4%, regrafts 6.5% and bullous keratopathy 6.5%.[3]

In another African study by Yonas et al conducted at the Eye bank of Ethiopia, KC accounted for only 11.1% of cases. The remaining 98.9% where all NKC with infective causes accounting for 61.1%. [23] A similar study done in Gaza and West Bank by R.De Cock showed varying results. Thirty seven percent (37%) were done for KC, 35.6% were for microbial keratitis, trachomatous corneal scaring and herpes simplex keratitis and the remaining 26.9% shared between regrafts, corneal dystrophy, trauma, bullous keratopathy, congenital glaucoma, chemical burns, limbal dermoid, and corneal scaring of unknown cause.[6]

In most Western series however, the commonest indication for PKP are pseudophakic bullous keratopathy followed by Fuchs dystrophy, corneal scaring and aphakic bullous Keratopathy (ABK). Infective causes are the lowest reason why PKP is done.[4] In New Zealand a study by the New Zealand National Eye Bank reported the indications for penetrating keratoplasty done over 13 years in children. Congenital anomalies accounted for 16%, acquired non traumatic causes 74%, and acquired traumatic causes 10%. [8] No single case was performed for keratoconus. There appear to be no separate study reporting indications in children in Africa.

2.2.0 Outcomes of PKP

The outcome of PKP can be measured in several ways. However the most important variables of outcome are in terms of graft survival and visual outcome. [13] Graft survival is in terms of graft clarity from time of surgery. [20] Several studies have shown that KC tends to have a higher survival rate compared to NKC causes of corneal blindness. Yorston et al has reported a probability of graft survival of 87.4% at 2 years for KC and 64.7% for other corneal pathologies in a study conducted at KEU. [3]

Outcomes in regrafts and combined procedures in which cataract or glaucoma surgery is combined with PKP are said to be poor, ranging between 0 – 50%.[10] A study carried out in India by Dandona et al reported a 5 year survival probability in regrafts of 21.2%.[24] A study by Robert et al done in Indianapolis USA to establish long term survival of corneal grafts showed that the survival rate for first time grafts was 90% at 5 years and 82% at 10 years.

The highest 5 year and 10 year survival rates were noted for primary grafts with KC (97% and 92% respectively), and Fuchs dystrophy (97% and 90% respectively).

Primary grafts for aphakic bullous keratopathy had the lowest 5 year survival rate at 70%.[4] No long term impact on blindness was assessed in this study. The high failure rate of grafts in NKC corneal pathologies would cause surgeons in the third world to tend to prefer providing PKP services to KC patients for maximal utilization of grafts which are usually donated from the West.[21]

In terms of visual outcome, KC eyes have shown better outcomes both in the long and short term. In the study by Yorston et al, preoperatively 55% of KC eyes were blind compared with 75.7% of the NKC eyes.[3] Postoperatively, only 5% of KC eyes compared with 41.7% NKC eyes were blind.[3] The impact of PKP on blindness is however usually lower in KC than in other corneal pathologies. This is because even when bilateral, KC patients tends to have the less affected eye having good vision unless the severity of the disease is equal in both eyes. The percentage blindness is therefore lower in KC than in other corneal pathologies before surgery.[8] In the study done in Gaza and West Bank by Cock et al, 12.7% of KC and 49% of NKC were blind preoperatively. Postoperatively, only 1.1% of KC and 25% of NKC eyes were blind in the better eye.[6]

2.3.0 Causes of Graft opacification after PKP.

The most important causes of graft opacification in most studies are bacterial infections, primary and secondary graft failures, graft rejection and recurrent diseases in the graft. In the Yorston study the highest causes of graft opacification were graft failures and infections (6%) which included endophthalmitis and bacterial corneal ulcer each accounting for 6% of graft opacifications.[3]

Recurrent corneal diseases reported were herpes simplex virus, mooren's ulcer and pseudophakic bullous keratopathy, together they accounted for 3.5% of graft opacification. In Gaza and West Bank however the largest cause of graft opacification reported was graft rejection at 10% surpassing infections which are usually higher in the third world.[6]

2.4.0 Donor tissue.

The corneas used are at Kikuyu Eye unit are usually donated mostly from the USA. Harvesting of donor corneas is usually carried out within 24 hours of the donor's death. Preoperative evaluation of the donor corneas include slit-lamp examination, and, ideally, specular microscopy.[1][9]Corneas from infants are too floppy are therefore not used due to the risk of high astigmatism. Those from donors over the age of 70 years are also discouraged especially for use in young patients due to the low endothelial count at this age.[9]

Corneas are not utilized if the donor had the following conditions, eye diseases like malignances, active ocular inflammation, previous intraocular surgery, Leukaemia and disseminated lymphoma. Systemic infections like HIV, viral hepatitis, syphilis and septicaemia also prevent the use of such corneas. Other diseases include CNS infections like systemic sclerosing panencephalitis, creutzfeldt-jakob disease, progressive multifocal leucoencephalopathy.[9, 10, 22] Thus several investigations are required to rule out these conditions. These are expensive and therefore apart from cultural beliefs, these may be contributing factors that prevent donation of corneas in the developing countries.

2.5.0 Storage of donor Tissue and donor age

The media used for storing donor tissue can either be short term, medium or long term. A study by Cock et al has reported no relationship between storage time, donor age and maintenance of graft clarity. The storage time in this study ranged between 1 to 27 days with an average of 11.9 days.[1] Despite this relatively long overall storage time, the rate of primary graft failure reported (1.2%) was no longer than in other series. [6] The correlation between endothelial cell loss and donor preservation time is however well established and argues for the earliest use of donor corneas. [6,10] There is an increased likelihood of long term graft failure if donor age is more than 70 years and the endothelial cell count is below 2000cells/mm^2 especially if these grafts are used in children who are likely to live longer. The correlation found so far has however been insignificant.[20,18]

2.6.0 Surgical Technique

2.6.1 Determination of graft size: This is done preoperatively with a variable slit beam. Intraoperatively, trial placement of triphen with different diameter is used. An ideal size is usually 7.5mm. Larger grafts are prone to anterior synechiae, vascularization and increased IOP. Smaller grafts have been seen to have a higher incidence of astigmatism. [9]

2.6.2 Excision of donor cornea: This precedes that of host cornea. The donor button is usually made 0.25mm larger than the host recipient site. [9] This facilitates water tight closure and minimizes postoperative flattening and possibility of postoperative glaucoma.

2.6.3 Excision of diseased host tissue: This is done with a triphen taking care of the iris and lens. Miosis is important for lens protection.

A surgical knife is usually used to enter the anterior chamber, then a knife or scissors is used to complete the excision after partial trephination. [10]

2.6.4 Fixation of donor tissue: This is done with 10/0 monofilament nylon. Some surgeons do interrupted sutures; others do continuous, while a combination of the two has also been used. [10]

Small sized corneal buttons have been found to be associated with a high average astigmatism in the long term.[5] Studies that have compared astigmatism in continuous and interrupted suturing techniques have reported no significant difference.[14] In the study by Yorston et al KC eyes had a higher average astigmatism of 4.2. No comparisons were made between different graft sizes and suturing techniques. [3]

2.7.0 Postoperative Management.

2.7.1 Steroids: Used topically in most cases. Q.I.D administration is recommended in the initial weeks then tapered depending on condition of the graft or the indication. Steroids are however used at low doses such as once daily for a year or more. [10, 42]

2.7.2 Cycloplegics: A course is given BD for upto 2 weeks. If persistent uveitis is present, they can be given for longer. [9]

2.7.3 Antimicrobials: They are given depending on the cause of corneal opacity. Oral acyclovir is given to prevent recurrence in herpes simplex keratitis. [9, 10, 51]

2.8.0 Postoperative complication.

These are divided into early and late complications. Some researchers have classified early complications as those occurring within 2 weeks of surgery. The commonly seen are persistent epithelial defects, leakage, flat AC, Uveal prolapse, uveitis, elevated IOP, hyphaema and infections. [9, 10, 15] Late complications include astigmatism, recurrence of initial disease with graft involvement, late wound separation, retrocorneal membrane formation, glaucoma and cystoid macular edema. Retinal detachment is another rare complication that has been reported. [10, 18, 22]

2.9.0 Graft failure

Early failure also called primary failure is characterized by opacification or clouding of the graft on first postoperative day. It results from endothelial dysfunction as a result of defective donor endothelium or operative trauma. [9]

Late failures are usually a result of rejection. Most occur between 6 months and 1 year. Rejection is either epithelial or endothelial. [19]

2.10 Graft rejection.

A linear epithelial opacity starting from the periphery is noted first in epithelial rejection. This is followed by subepithelial infiltrates called Krachmer spots with associated mild iritis. In endothelial rejection, iritis and inflammation are noted at the graft-host junction. Followed by development of linear endothelial precipitates called Khodadoust line. Edema is the end result [9, 10, 16].

According to Kaminska et al from Poland corneal rejection occurs more frequently in patients with one or more risk factors, particularly deep stromal vascularization, the use of topical glaucoma medication and being young. Rejection can however be treated with intensive topical steroids. Periocular and oral steroids have also been used. Occasionally systemic immunosuppression may be necessary. [9, 18] Arenas et al from Spain has reported successful use of intrastromal depot cortisone injection in the treatment of graft rejection. The vast majority of cases (81%) improved clinically within a few days. Graft rejection as a cause of graft failure remains low with early recognition and appropriate management In the study by Yorston et al, out of 46 grafts that had rejection, only 11 (5.1%) resulted in graft failure.

3.0.0 Definitions.

The following definitions will be used in the study:

3.1.0 Primary failure: Opacification of the graft from first post operative day (early endothelial failure).[3]

3.2.0 Secondary failure: Irreversible change in the graft preventing recovery of useful vision after the graft had been initially clear after PKP (late endothelial failure).[4]

3.3.0 Time of failure: This will be the postoperative examination at which the patient was seen to have a failed graft.[3]

3.4.0 Graft survival: Will be in terms of graft clarity at particular times of follow up.[14]

3.5.0 Long term survival of graft: This will be defined as a clear graft for at least 5 years after surgery.[4]

3.6.0 Survival or failure of graft: This will be taken from status of graft at the last visit of the patient.[3]

3.7.0 Visual acuity: This will be used to refer to the vision in one eye.

3.8.0 Visual status: This term will be used to refer to the vision of the patient (that is vision in the better eye).

Visual acuity will be classified according to the WHO recommended categories of visual loss.

Blindness will be defined as vision less than 3/60 to NPL.

4.0.0 Study justification.

To date only few studies have reported long- term PKP graft survival (at least 5 years) for a large number of eyes, more so in developing countries.

The purpose of this study was to document both short- term and long- term corneal graft survival rates and identify the causes and timing of graft failure in the different diagnostic indications for which PKP was done.

The study was also going to help to identify optimal cases that can have long term benefit from the corneal grafts considering that they are donations from over seas and therefore not readily available.

There was also need to identify common complications that would lead to graft failure, i.e. there frequency and timing to help schedule follow up for early identification and management to increase graft survival.

5.0.0 Objectives:

5.1.0 Major:

1. To establish short and long term survival rates and visual out come, of corneal grafts performed at Kikuyu Eye Hospital between from 1993 to 2003.

5.2.0 Specific objectives:

1. To establish indications for which PKP was performed.

2. To establish common post operative complications and causes of failure.

3. To establish the association of graft survival, with the following:

       (a). donor age and recipient age.

       (b). endothelial count of donor tissue,

       (c).cadaveric and storage time of tissue.

       (d). size of corneal button.

6.0.0 Research Methodology.

6.1.0 Study design.

Retrospective case series, hospital based.

6.2.0 Study period.

The study was carried out in working days for one complete month from April to

May, 2006.

6.3.0 Study location.

Kikuyu Eye Unit.

6.4.0 Sample size.

An average of 25 eyes are operated per year. In 11 years about 250 eyes were expected

to have been operated.

6.5.0 Case definition.

Any patient who had PKP at KEU from 1993 to 2003.

6.6.0 Inclusion criteria.

All patients who had PKP at KEU during the stated period. Missing records

were reported as such.

6.7.0 Resource Personnel.

Personnel at the registry.

Statistician.

Typist.

6.8.0 Ethical Considerations.

All information acquired from patients files was kept confidential. No photocopies of records were made and no patient was referred to by name. The information obtained is only to be used for the purposes of this study.

6.9.0 Study Materials.

Questionnaire.

Files from the registry of patient who had PKP at Kikuyu Eye Hospital between 1993 and 2003.

6.10 Procedure and data analysis.

The data from the files was entered into the questionnaire by the investigator. The measurements of outcome were in terms of graft transparence, visual acuity in operated eye and visual acuity in the better eye (visual status) of the patient. Data in put and analysis were carried out with SPSS for windows and Microsoft excel and standard procedures employed for data validation. The method of Kaplan and Meier of SPSS for windows was used to analyze the probability of graft survival.

7.0.0 Results.

A total of 237 patients had PKP at KEU between 1993 and 2003. Thirteen patients where lost to follow up. Two patients were followed up in Mombasa due to distance. Two hundred and twenty seven eyes of 223 patients were therefore included in the study of which, 4 patients had PKP in both eyes. The mean follow up for KC patients was 5.25 years compared with 4.55 for NKC patients. There was however, no difference in follow up between KC and NKC,(p= 0.117). The mean follow up time for patients whose grafts survived was 5.47 years compared with 3.85 years for patients whose grafts failed (p<0.001).

Table 1:   Age distribution of 223 patients.

Age (years)	Females	Males	Total	(%)
0-15	30	45	75	(33.6)
16-30	34	46	80	(35.9)
31-45	16	11	27	(12.2)
46-60	12	9	21	(9.4)
61-75	6	9	15	(6.7)
76-90	0	5	5	(2.2)
Total	98	125	223	(100)

Mean – 26.02,   Std - 18.   Median - 17,   Mode - 17

Figure i

Age distribution in 223 patients
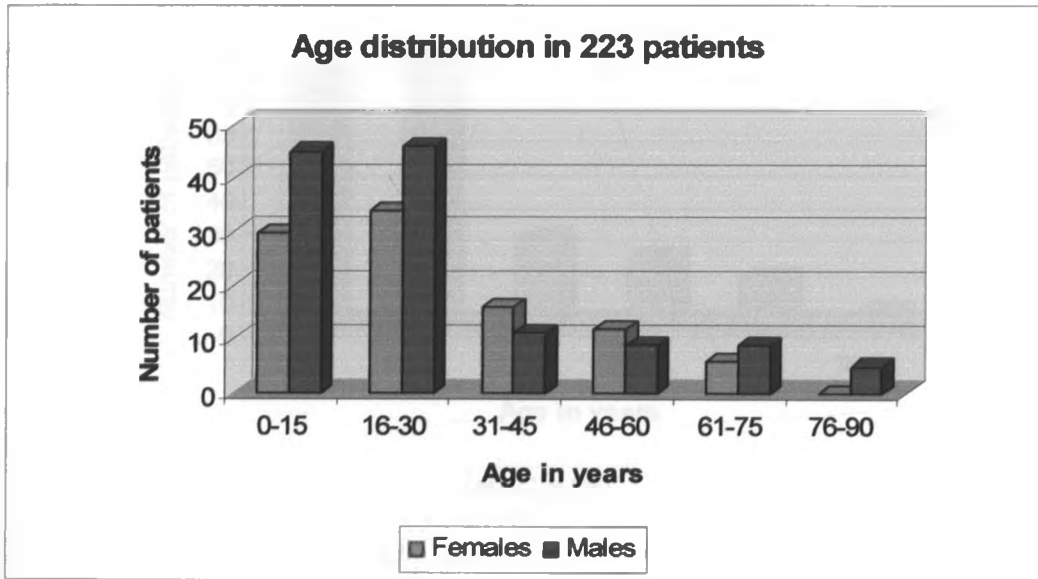
There were 125 males (56.1%) and 98 females (43.9%). The oldest female patient was 74 years compared with 83 for males. The youngest patient was 6 years old with a similar mode of 17, in both groups.

Table 2:   Age distribution according to indication for PKP.

Age (years)	KC	(%)	NKC	(%)	x^2	P – value.
0-15	62	(46.3)	13	(14.6)	148.4	<0.001
16-30	66	(49.3)	14	(15.7)		
31-45	6	(4.4)	21	(23.6)		
46-60	0	(0)	21	(23.6)		
61-75	0	(0)	15	(16.9)		
76-90	0	(0)	5	(5.6)		
Total	134	(100)	89	(100)		

Figure ii.
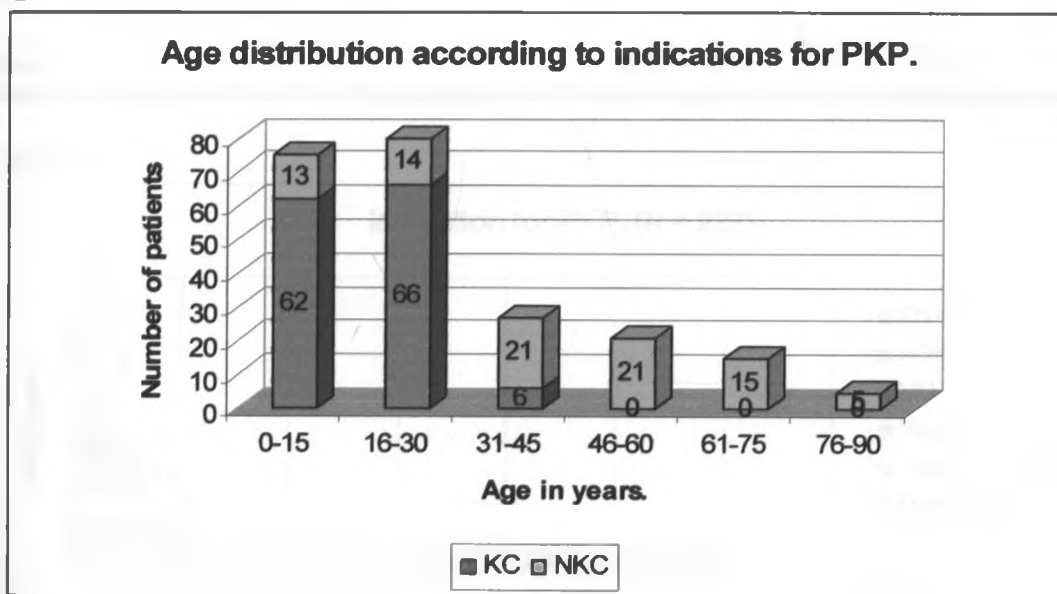
The preoperative diagnosis for 134 (60.1%) patients was KC and NKC for 89 (39.9%) patients as shown in table 2 above. The age range for KC patients was 6 to 41 years with an average age of 17.3 whilst NKC patients had an age range of 6 to 83 years with an average age of 40.2. There was a statistically significant difference in age between the two groups of patients (p<0.001).

Table 3:   Indications for PKP.   N = 227

Indication	Number of patients	(%)
Keratoconus	138	(60.8)
PBK	17	(7.5)
Trauma	15	(6.6)
Dystrophy	12	(5.3)
HSV	9	(4.0)
Trachoma	8	(3.5)
Vitamin A deficiency	6	(2.6)
Fungal	7	(3.1)
Regrafts	5	(2.2)
MU	4	(1.8)
Corneal scar	3	(1.3)
ABK	3	(1.3)
Total	227	(100)

Figure iii.

Indication for PKP. (N = 227)
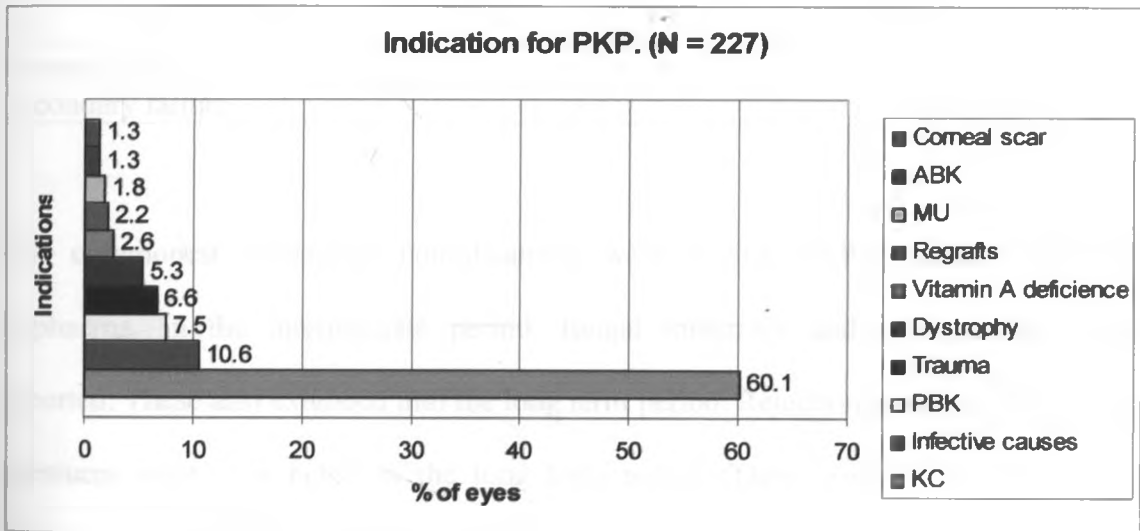
The most common preoperative diagnosis was Keratoconus (60.1%). Of the non keratoconus indications, the most important were the infective causes of corneal blindness (10.6%), PBK (7.5%), corneal dystrophies (5.3%) and trauma (6.6%).

Table 4: Postoperative complications.   (N = 227)

Complications.	Timing.		
	Immediate. 0 - 72hours.	Intermediate. >72 hours - 2 weeks	Long term. >2 weeks.
PEP	42		
Wound leak	10		
Lose suture(s)	11		
Flat AC	2		
Uveal prolapse	3		
Hyphaema	14		
Uveitis	12		
Bacterial ulcer	6		1
Endophthalmitis	3	1	1
Suture abscess	5		
Recurrent MU			3
Recurrent HSV		8	
Fungal infection		1	2
High pressures		7	3
Cataract			3
Rejection			49
RD			2
Primary failure	11	3	
Secondary failure			15

The commonest immediate complications were uveitis, PEP, primary failure and hyphaema. In the intermediate period, fungal infections and recurrent HSV were reported. These also extended into the long term period. Rejection, cataract, RD and high pressures were only noted in the long term period. There were 11 primary and 15 secondary failures accounting 11.5% of complications. Apart from primary and secondary failure, infections were more likely to cause graft failure compared to other complications ($p < 0.001$).

Table 5: Graft failure according to indications in 227 eyes at Kikuyu Eye Unit.

Indication	Survived	(%)	Failed	(%)	OR	p - value
Keratoconus	100	(72.5)	38	(27.5)	0.56	0.043
PBK	12	(70.6)	5	(29.4)	0.85	0.982
Dystrophy	11	(91.7)	1	(8.3)	0.18	0.109
Trauma	10	(66.7)	5	(33.3)	1.00	0.949
HSV	3	(33.3)	6	(66.7)	4.44	0.025
Fungal	3	(42.9)	4	(57.1)	2.86	0.219
Regrafts	3	(60)	2	(40)	1.39	0.662
Corneal scar	3	(100)	0	(0)	----	-----
Vitamin A	3	(50)	3	(50)	2.11	0.394
Trachoma	2	(25)	6	(75)	6.66	0.009
ABK	2	(66.7)	1	(33.3)	1.03	0.553
MU	1	(25)	3	(75)	6.42	0.103
Total	153	(67.4)	74	(32.6)		

Trachoma and HSV had significantly higher risks for failure compared with other cases. The other cases with high risk for failure included MU and Vitamin A and fungal infections, however their p – values were not significant.

Table 6: Causes of graft opacification. (N = 227)

Causes	KC	NKC	Total	% N= 227	x^2	p- value
Abscess	3	2	5	2.2	226.31	<0.001
Bacterial Ulcer	3	1	4	1.8		
Endophthalmitis	3	2	5	2.2		
Trauma	1	0	1	0.4		
Primary failure	10	4	14	6.2		
Secondary failure	11	4	15	6.6		
Graft rejection	3	4	7	3.1		
Fungal infection	0	2	2	0.9		
Recurrent HSV	0	6	6	2.6		
Recurrent MU	0	3	3	1.3		
Recurrent PBK	1	4	5	2.2		
PED	2	2	4	1.8		
Glaucoma	1	1	2	0.9		
Vitreous Touch	0	1	1	0.4		
Total	38	36	74	32.6		

A total of 74 (32.6%) grafts where opacified (failed). Of these 38 were for KC while 36 were for NKC. The commonest causes of graft opacification in both the KC and NKC eyes were primary failure(6.2%) and secondary failure (6.6%). Grafts for NKC were more likely to get opacified/fail compared with the grafts for KC (p<0.001).

Figure iv: Graft survival.
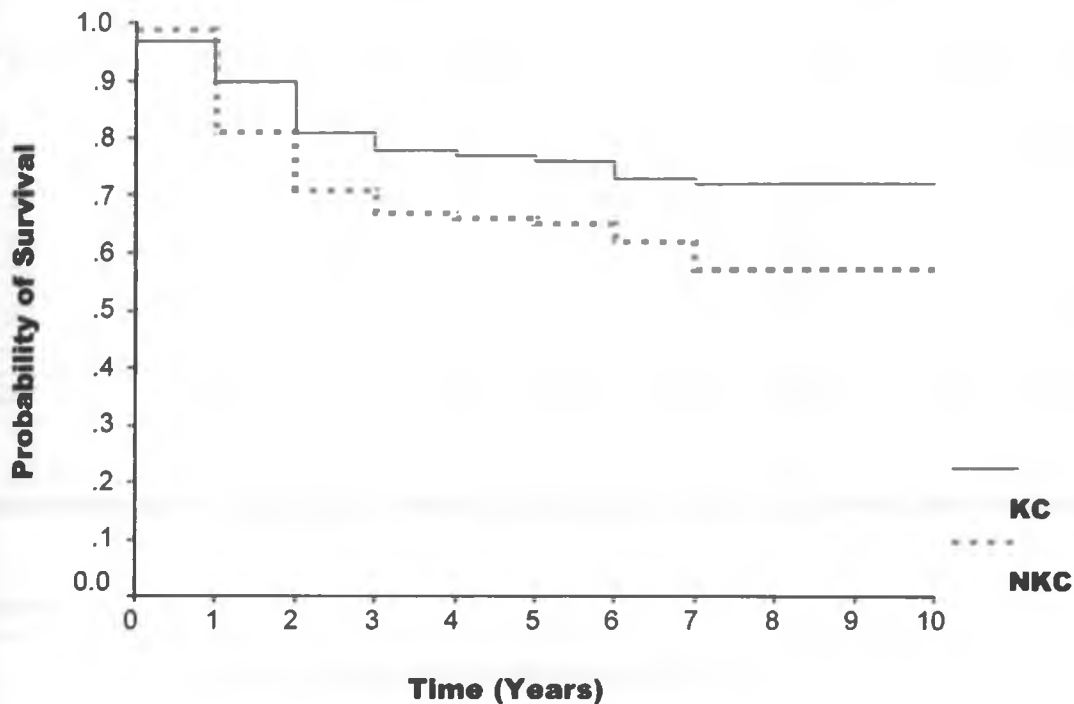
The probability of survival was determined using the method of Kaplan and Meier (figure iv above). Cases with follow up less than 1 year were treated as censored cases. Survival time was taken from the patients last date of clinic attendance. At 2 years, the probability of survival for KC was 81.1% (95%CI, 74.7 – 87.4%) while that for NKC was 71.3% (95%CI, 60.1 – 81.9%). The probability of survival for KC was 76.3% (95%CI ,70.1 – 82%) at 5 years and 72.3% (95%CI, 66.4 – 77.7%) at 10 years. The probability of survival for NKC cases was 65.3% (95%CI, 55.6 – 75.8%) at 5 years and 57% (95%CI, 48.6 – 66.1%) at 10 years.

Table 7: Age of patient and graft status in 227 eyes.

Age in years	KC				NKC			
	Survived	*(%)*	*Failed*	*(%)*	*Survived*	*(%)*	*Failed*	*(%)*
0-15	45	(72.6)	17	(27.4)	8	(61.5)	5	(38.5)
16-30	50	(71.4)	20	(28.6)	8	(57.1)	6	(42.9)
31 - 45	5	(83.3)	1	(16.7)	14	(66.7)	7	(33.3)
46 - 60	0	(0)	0	(0)	13	(61.9)	8	(38.1)
61 - 75	0	(0)	0	(0)	9	(60)	6	(40)
76 - 90	0	(0)	0	(0)	1	(20)	4	(80)
Total	100	(72.1)	38	(27.9)	53	(60.4)	36	(39.6)

$x^2 = 13.4$ $p = 0.081$ $x^2 = 2.8$ $p = 0.314$

Figure v:

Age of patient and graft status. N = 227

The was no statistically significant association between age of graft recipient and graft status in either KC or NKC eyes ($p = 0.081$ and 0.314 respectively).

Table 8: Endothelial count and graft status. (N = 227)

ECC	Survival	(%)	Failed	(%)	x^2	P – value
		Graft status				
< 1500	25	(61.0)	16	(39)	2.034	0.73
1501-2000	34	(69.4)	15	(30.6)		
2001-2500	33	(63.5)	19	(36.5)		
2501-3000	31	(70.5)	13	(29.5)		
> 3000	30	(73.2)	11	(26.8)		
Total	153	(67.4)	74	(32.6)		

Figure vi.

Endothelial count and graft status. (N = 227)
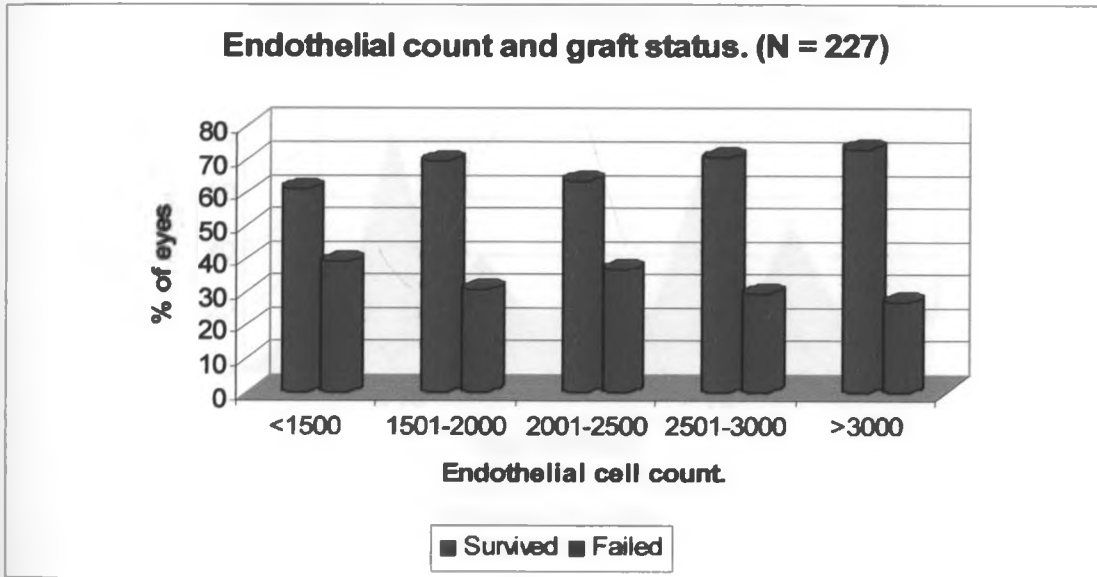
The range of endothelial count in the donor corneas was 1123-3504/mm² with an average count of 2703.4. There was no correlation between graft status and endothelial count (p=0.730). There was no difference in outcome if KC and NKC eyes were analyzed separately (p- values 0.069 and 0.081 respectively).

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Table 9: Age of donor and graft status. (N = 227)

Age	Survived,	(%)	Failed,	(%)	OR (95%CI)	X^2	P-Value
			Graft Status				
≤ 70	105	(70.9)	43	(29.1)	1.58(0.85- 2.92)	2.4	0.119
> 70	48	(60.8)	31	(39.2)			
Total	153	(67.4)	74	(32.6)			

Figure vii.

Donor age and graft status in 227 eyes.

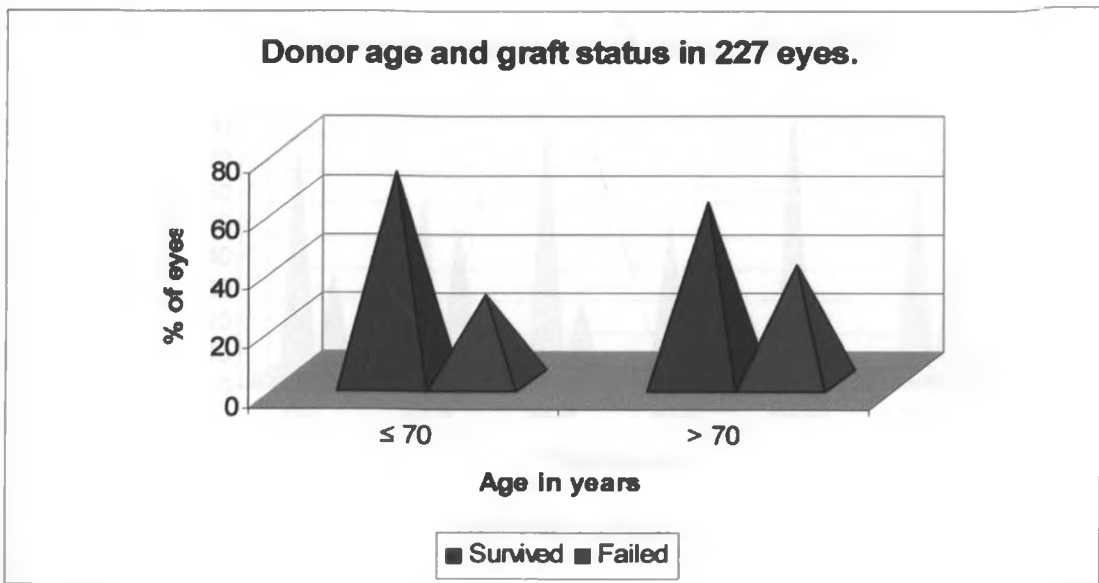Table 8 and figure vi shows the relationship between donor age and graft status.The age range of the cornea donors was 42 to 83 years with an average age of 62.3. The percentage of failed grafts was higher in patients who had corneal grafts from donors older than 70 years compared with those with grafts from donors younger than 70 years. However the p – value (0.119) for this observation was insignificant.

Table 10: Cadaveric time and graft status. (N = 227)

| Time(hours) | Graft status. | | | | | |
	Survived	(%)	Failed	(%)	x^2	p – value.
0 -2	29	(69)	13	(31)	14.62	0.012
>2-4	17	(53.1)	15	(46.9)		
>4-6	41	(77.4)	12	(22.6)		
>6-8	11	(45.8)	13	(54.2)		
>8-10	39	(79.6)	10	(20.4)		
>10-12	16	(59.3)	11	(40.7)		
Total	153	(67.4)	74	(32.6)		

Figure viii.

Cadaveric time and graft status. (N = 227)
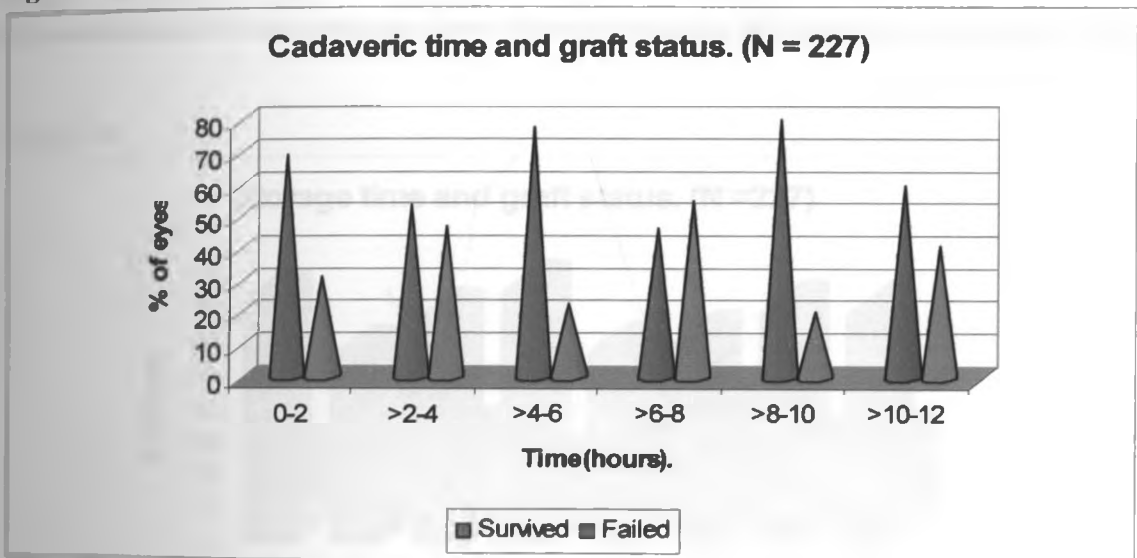
There was an association between cadaveric time and graft failure (p=0.012). When KC eyes were analyzed alone, a clear association was shown between cadaveric time and graft status with the number of failed grafts increasing with increasing cadaveric time (p=0.007). There was however no relationship shown when NKC eyes where considered alone (p=0.08).

Table 11: Storage time and graft status. (N = 227)

Time (days)	Survived	(%)	Failed	(%)	x^2	P- value
		Graft status.				
6	34	(73.9)	12	(26.1)	14.63	0.067
7	18	(56.3)	14	(43.8)		
8	27	(67.5)	13	(32.5)		
9	32	(76.2)	10	(23.8)		
10	15	(57.7)	11	(42.3)		
11	11	(61.1)	7	(38.9)		
12	7	(70.0)	3	(30.0)		
13	9	(69.2)	4	(30.8)		
Total	153	(67.4)	74	(32.6)		

Figure ix.

Storage time and graft status. (N =227)
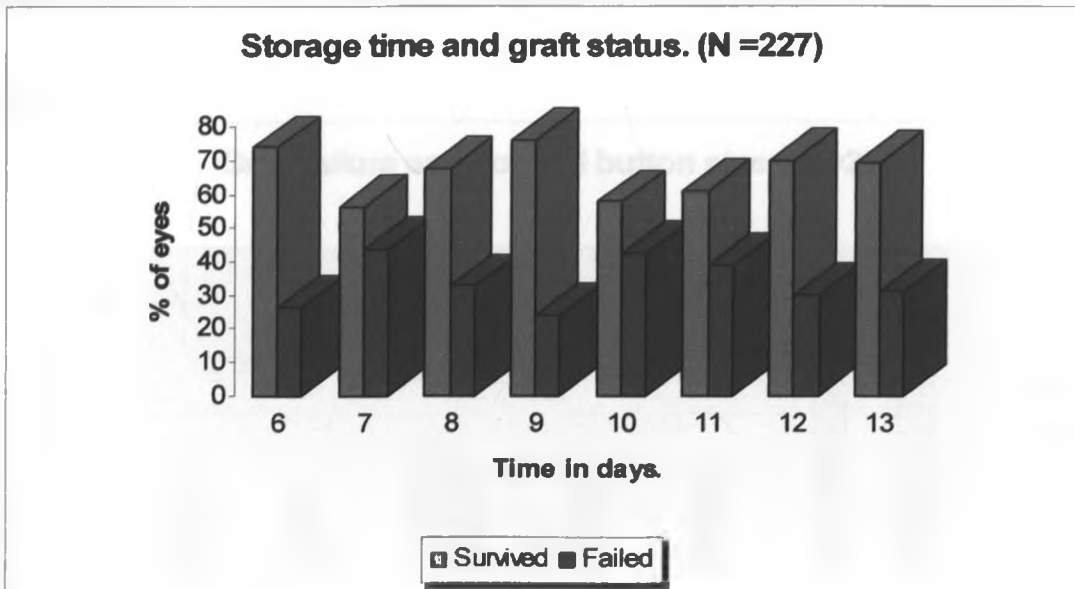
There was no association shown between storage time and graft status (p=0.067). The results were not different when KC and NKC eyes were analyzed separately (p = 0.053 and 0.061 respectively).

Table12: Corneal button size and graft status. (N = 227)

Corneal button size (mm).	KC				NKC			
	Survived	(%)	Failed	(%)	Survived	(%)	Failed	(%)
6.5	7	(63.6)	4	(36.4)	0	(0)	0	(0)
7.0	17	(70.8)	7	(29.2)	0	(0)	0	(0)
7.5	13	(50)	13	(50)	8	(61.5)	5	(38.5)
8.0	37	(78.7)	10	(21.3)	16	(57.1)	12	(42.9)
8.5	25	(92.6)	2	(7.4)	29	(61.7)	18	(38.3)
9.0	1	(100)	0	(0)	0	(0)	1	(100)
9.5	0	(0)	2	(100)	0	(0)	0	(0)
Total	100	(72.1)	38	(27.9)	53	(60.4)	36	(39.6)

$x^2 = 2.5$ $p = 0.238$ $x^2 = 4.3$ $p = 0.091$
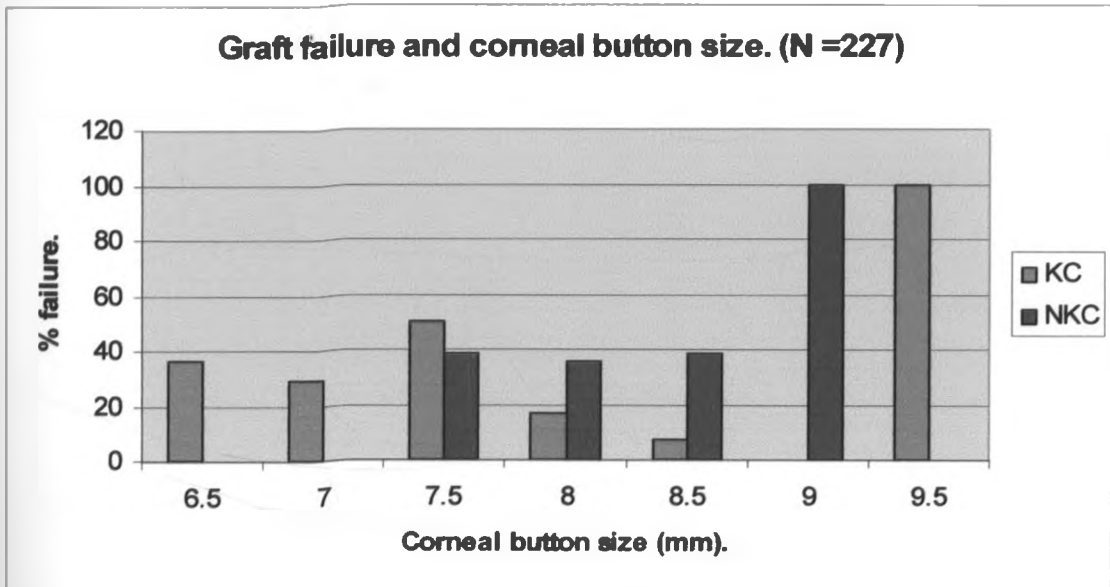
Figure x:

The table and figure above shows the relationship between graft status and corneal button size. Only 3 grafts were more than 8mm in size and they all failed. There was no statistically significant association between graft status and corneal button size.

Figure xi. Size of donor button and average astigmatic error. (N =227)

Figure xi. Size of donor button and average astigmatic error. (N =227)

The average astigmatic error tended to increase with reducing donor button size. The correlation coefficient at a significant p – value of 0.01 was 62%.
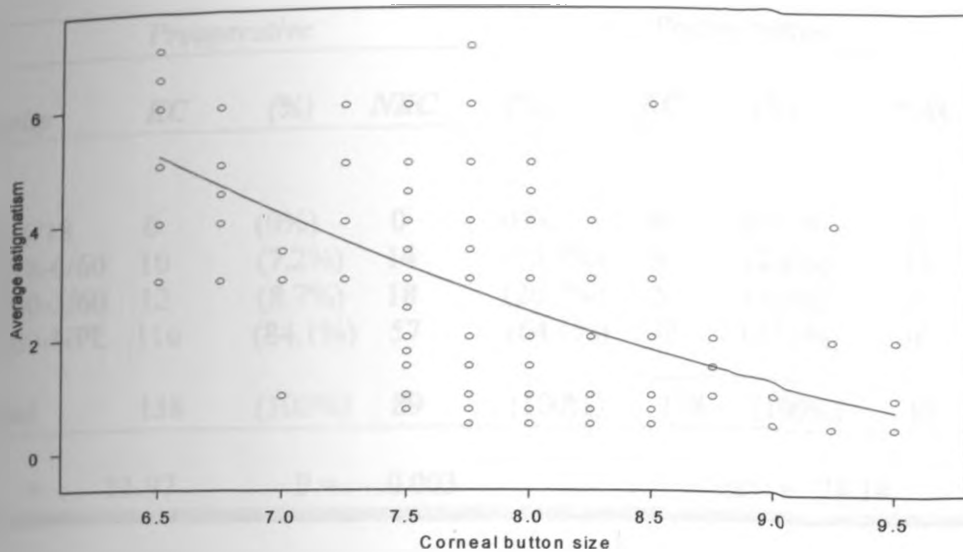
Table13: Preoperative and postoperative visual acuities (best corrected)   (N = 227)

Acuity	Preoperative				Postoperative			
	KC	*(%)*	*NKC*	*(%)*	*KC*	*(%)*	*NKC*	*(%)*
6/6-6/18	0	(0%)	0	(0%)	91	(65.9%)	38	(42.7%)
<6/18-6/60	10	(7.2%)	14	(15.7%)	4	(2.9%)	15	(16.9%)
<6/60-3/60	12	(8.7%)	18	(20.2%)	5	(3.6%)	0	(0%)
<3/60-NPL	116	(84.1%)	57	(64.1%)	38	(27.6%)	36	(40.4%)
Total	138	(100%)	89	(100%)	138	(100%)	89	(100%)

x^2 =   11.97   P =   0.003 x^2 = 28.14   p < 0.001

Figure xii.

Preoperative and postoperative visual acuites. (N =227)
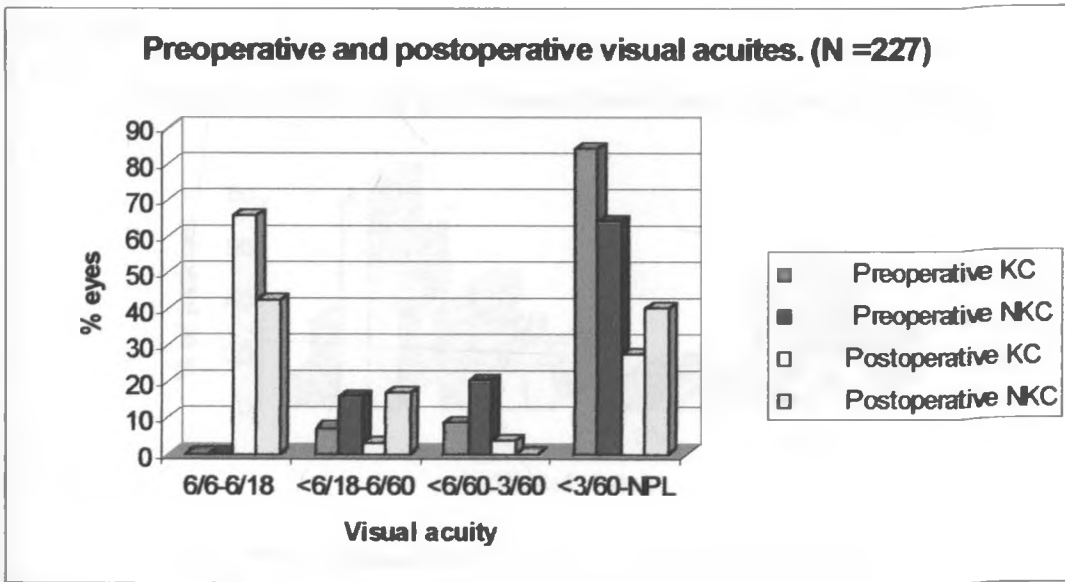
KC eyes were more likely to have visual acuities < 3/60 preoperatively compared with the NKC eyes (p =0.003). Post operatively however, KC eyes were more likely to have visual acuities of 6/18 and better (p <0.001).

Table 14: Preoperative and postoperative visual status in 223 patients.

Acuity in better eye	Preoperative				Postoperative			
	KC	(%)	NKC	(%)	KC	(%)	NKC	(%)
6/6-6/18	15	(10.8%)	29	(32.7%)	105	(78.4%)	50	(56.2%)
<6/18-6/60	52	(39.1%)	20	(22.5%)	20	(14.9%)	15	(16.9%)
<6/60-3/60	7	(5%)	7	(7.8%)	3	(2.2%)	4	(4.5%)
<3/60-NPL	60	(45.1%)	33	(37%)	6	(4.5%)	20	(22.4%)
Total	134	(100%)	89	(100%)	134	(100%)	89	(100%)

x^2 = 18.175   P < 0.001 x^2 = 19.63   p < 0.001

Figure xiii.

NV = Normal vision, VI = Visual impairment, SVI = Severe visual impairment.

Preoperatively, NKC patients were more likely to have normal vision compared with the KC eyes (p < 0.001). Postoperatively however, NKC were more likely to be blind compared with the KC patients (p < 0.001).

Table15: Change in visual status. (N = 223)

Indication.	Better.	(%)	Same.	(%)	Worse.	(%).	x^2	P – value.
			Visual status.					
KC	82	(36.8)	47	(21.1)	5	(2.2)	43.15	<0.001
NKC	28	(12.6)	29	(13)	32	(14.3)		
Total	110	(49.4)	76	(34.1)	37	(16.5)		

Figure xiv.

Change in visual status. (N = 223)
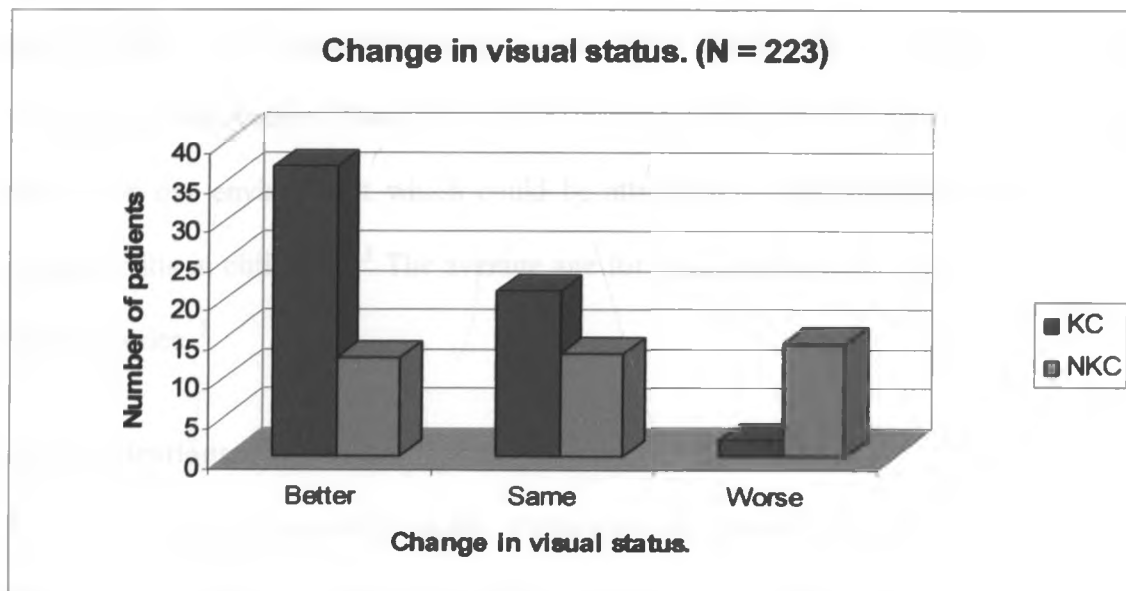
There was a statistically significant difference in change in visual status in the KC and NKC patients with the NKC patients more likely to have a worse visual status outcome than the KC patients (p <0.001).

8.0.0 Discussion.

8.1.0 Age.

The age range for all the patients included in the study was 6 to 83 years with a mode of 17 years (table 1). This was similar to other series carried out both in developing and developed nations. However, the average age for KC patients (17.3) was less compared with other studies especially from the developed world. This was most likely due to the non-availability of contact lens services in our environment which would delay the time to surgical intervention. There also seem to be a high prevalence of KC in younger patients in our environment which could be attributed to the high incidence of vernal conjunctivitis in children. [2,3] The average age for NKC patients (40.2 years) was similar to other series. [3]

8.2.0 Indications.

The most frequent diagnosis was KC which was the indication for grafting in 60.8% of the patients (table 3). This was higher compared with what was seen in the study conducted earlier by Yorston et al in the same eye unit in which the proportion of KC was 50%.[3] The increase in the number of KC cases in this series could be reviewing the surgeon'ss preference for KC cases due to there good outcome shown in various studies including the study conducted in the same unit by Yorston et al. [3] The proportion of PKPs performed for bullous keratopathy (8.8%), was higher than that from most series from developing countries. [3,6,24]

There was even an increase from the study by Yorston et al in which the proportion of bullous keratopathy was 6.5%.[3] This could reflect the large number of cataracts operated per year and the relatively good follow up of these patients Kikuyu Eye Unit. Major causes of corneal blindness in Africa, trachoma and vitamin A deficiency only accounted for 14 out of 223 cases out of which 9 cases failed. The poor outcome in this category of patients shows that PKP still has minimal role in combating corneal blindness in Africa. Preventive measures that address these diseases will therefore continue to be an important tool to combat this form of visual loss. There were no cases of measles or bacterial keratitis. Infective causes of corneal blindness together accounted for 10.6% of all the eyes in this study which was higher than in most Western series.[31, 30]

8.3.0 Donor materials.

A total of 238 grafts were donated from eye banks in USA. One of the grafts could not be used due to its unfavorable state. There were no grafts obtained locally. In a study conducted in Australia by William et al looking at long-term outcome after corneal transportation, primary failures were sited as the greatest possible hindrance to PKP with donated corneas transported over long distances. [37] The number of primary failures in this study had increased compared with that found in other studies. Of the 237 grafts that were used for grafting ,14 (6.2%) were primary failures (table 6) which was two times higher than what was found in the study by Yorston et al. [3] There were no primary failures in the study done in Ethiopia by Yunas et al. [23] Although primary graft failures had increased in this study, the proportion was still small. showing that it is possible to transport corneas thousands of kilometers from there places of origin for PKP to restore sight.

Sixty nine percent (69.3%) of the grafts were stored in Optisol while 20.5% were stored in DexSol. The storage mediums for the remaining 11.2% of the grafts were not entered on the form containing graft information. There was no significant difference in outcome both in terms of vision and graft survival in the grafts stored either in Optisol or DexSol (p = 0.031 and 0.731 respectively). A randomized clinical trial conducted by Lass et al at Western Reserve University in Ohio has reported no difference in outcome between grafts stored in DexSol or Optisol in terms of vision and graft survival. However intraoperatively grafts stored in DexSol were found to be significantly thicker than those stored in Optisol. A year latter, the mean endothelial cell lose for grafts stored in Optisol was 15% compared with 21% for DexSol. [43] Studies have shown a higher lysosomal enzymatic activity in grafts stored in DexSol. [43] This study has shown that the two storage mediums can be used with comparable results both in the short and long term.

8.4.0 Complications.

Within the first 72 hours , 108 patients (47.6%) had complications (table 6). Of these, PEP, uveitis, lose sutures and hyphaema were the commonest. Endophthalmitis, bacterial corneal ulcer and suture abscess only accounted for 6.2% of all complications in the first 72 hours. These infections could have resulted from storage media contamination, poor sterilization procedures in theatre and wound contamination during swabbing or insertion of drops in the ward.

In the intermediate period (>72 hours to 2 weeks) more infective complications were reported. These included 8 cases of recurrent HSV, and 1 case of fugal keratitis.

Recurrence of HSV is likely if the patient continues the use steroid without adding antivirals like acyclovir. After two weeks, further 3 cases of fungal infections were seen. In total infective complications appeared in 25 (11%) patients. The figure was higher than found in most Western series.[18, 30] This can be explained by the poor hygiene, poor compliance with prescribed medication and the fact that most patients in our environment can not afford to buy all necessary medications. There was however, a reduction in this series compared to what was found in the series by Yorston et al in which the proportion of infective complications was 15.7% of all patients.[3] This could be a result of better experience and recognition of those at risk leading to better management to prevent infection in operated eyes.

Other complications after two weeks included 2 cases of recurrent MU, 3 cataracts and 3 cases of high pressures. The highest number of late complications were 49 cases of rejection which accounted for 21.6% of all eye operated. The average time for the appearance of rejection was 5.7 months with a range of 4 to 9 months. This was comparable to findings in studies in Australia and the West in which the average time of appearance of rejection was 5.4 months and 6.3 months respectively. [17, 38,]

8.5.0 Graft failure.

The number of failed grafts was 74 (32.6%) out of 227 grafts (table 5). This was higher than in the study by Yorston et al (21.8%). [3] This could be because, the patients in this study were followed up longer than those in the study by Yorston et al. [3]

There were 14 primary and 15 secondary graft failures, which together accounted for 39.2% of all failed grafts. There was no association between age of donor and primary or secondary failures (p = 0.633). Most of the patients with secondary failure had stayed with the graft longer than 4 years. Nishimura et al has reported a chronic endothelial cell loss in transplanted corneas with late endothelial failure. The reported risk factors for late endothelial failure included low endothelial count preoperatively, aphakia or pseudophakia, older recipient age and older donor age. [42] In this study there was no association between failure and all the risk factors mentioned above. However, most of the grafts that had endothelial failure whether late or early, also had a higher cadaveric time, which was significantly associated with failure especially in KC eyes (p =0.007).

Infections were the second largest cause of graft failure. Out of 25 cases of bacterial, viral and fungal infections, 22 (88%) resulted in graft failure accounting for 29.7% of all graft failures. Infections were more likely to cause graft failure compared with other complications (p= 0.007). Grafts are more susceptible to destruction by infection especially those occurring in the first two weeks postoperatively. Intense control and prevention of infections during this period would reduce on the number of failing grafts. [32, 35]

PED was a mostly benign complication resulting in only 4 graft failures out of 41 eyes that had this complication. Wagoner et al in Saudi Arabia reported an increased risk of PEDs with increasing storage time over 7 days, although there presence did not have a statistically adverse impact on graft survival or visual outcome. [39]

This is particularly because the complication is epithelial, therefore, with good management complete reepithelialisation takes place in affected grafts.

Of the 49 eyes that had graft rejection, only 7 (14.3%) resulted in graft failure. In the study by Yorston et al, 11 (23.9%) grafts failed out of 46 that had graft rejection. [3] The improvement in this study could be as a result of improved recognition and early treatment of these complications.

The highest risk for failure was observed in eyes that had trachoma and HSV as their preoperative diagnosis (OR 6.66, p=0.009 and OR 4.44, p=0.025 respectively). The high rate of failure in HSV eyes was mostly due to recurrence of HSV in the graft. Like in trachoma eyes, most of HSV eyes had vascularization into the scared cornea which is associated with a higher graft failure rate.

Graft failure was shown to have no association with endothelial count and donor age (p = 0.730 and 0.119 as shown in tables 8 and 9 respectively). Most studies conducted elsewhere have reported contradicting views. A randomized controlled trial conducted in France by Gain et al investigating the suitability of corneas from donors older than 70 years of age showed poor macroscopic and microscopic appearance of the grafts preoperatively. [30] However within 25 month follow up, there was no statistically significant difference in outcome when compared with grafts from younger donors. Another study by Thuret et al, reported contradicting results with graft survival decreasing with increasing donor age and reducing endothelial cell count. [31] There was also no association between storage time and graft survival (table 10).

Similarly Gonnah et al in Gaza West Bank showed that the likelihood of graft survival, and of achieving a visual outcome of 6/18 or better, or of suffering a visual outcome of 3/60 or worse, was not statistically significantly affected by progressively longer periods of donor storage time for the entire study population or for any recipient diagnosis .[24] A study by William et al reported that graft survival fell with increasing recipient age.[40] The study also showed that elderly recipients suffer more complications and co-morbidities in the grafted eye than younger recipients. In this study (table 7, figure v) no association was found between recipient age and graft status in both KC and NKC eyes (p = 0.081 and 0.314 respectively). With 64.1% of the KC and 38.4% 0f the NKC patients having reported allergic conjunctivitis in the age groups younger than 20 years, a higher failure rate was expected in this age group. However the severity of the reported allergy could have been such that it was adequately treated postoperatively by the topical steroids used as postoperative treatment for PKP. Studies that have reported atopy as a risk factor for graft failure (Kuchle et al) have not quantified what severity of the disease posses a risk. [39]

Inuoe et al reported no relationship between graft failure and size of corneal graft.[41] Trigui et al has however shown an increase in graft rejection associated with graft diameters greater than 8mm. [38] This observation was also seen in this study with significant p – value of 0.0031. Nevertheless, rejections only resulted in 7 failures out of 19 rejections reported. No statistically significant association was found between graft size and graft status (p = 0.238 and 0.091 respectively) (table 12).

Thuret et al has reported fewer epithelial abnormalities with shorter death to preservation time (cadaveric time). [31] Postoperatively more decement folds and stromal oedema was associated with increasing death to preservation time. However, in the long run no statistically significant difference was seen in outcome. In this study, there was a significant association between cadaveric time and graft status with a p- value of 0.012, however the graph was difficult to interpret (table 10) due to other confounding factor especially in the NKC group. When confounders are reduced by analyzing KC and NKC eyes separately, a clear association between cadaveric time and graft failure in KC cases was reviewed, with rate of failure increasing with increasing cadaveric time (p=0.007). In NKC eyes, probably other risk factors for failure could have outweighed the significance of cadaveric time in causing failure, the relationship was therefore insignificant (p=0.08).

8.6.0 Astigmatism.

The average astigmatic error for keratoconus eyes (2.9D) was slightly less than that for NKC eyes (3.2D). There was a statistically significant difference in astigmatic error between KC and NKC eyes (p=0.012). These results were different from those reported by Yorston et al in which the KC eyes had a higher average astigmatic error of 4.2D compared with the NKC eyes (3.8D).[3] The difference in this study could be attributed to the higher percentage (14%) of eyes grafted with corneal buttons less than 7mm in KC eyes compared with 6.3% for the NKC eyes.

There appeared to be a correlation between corneal button size and average astigmatic error with the astigmatism increasing with reducing corneal button size (figure xi).

However the correlation coefficient at a p- value of 0.01 was only 62% in an inverse direction. The other 38% of astigmatism not accounted for by corneal button size could be explained by other factors such us the suturing methods used, indications for surgery, size of corneal button versus size of recipient site and factors like experience of the surgeons in performing PKP.

8.7.0 Graft survival.

Generally studies have shown a higher rate of survival for KC eyes compared with NKC eyes. [3, 24, 26] This tends to be exaggerated if a large number of high risk eyes are included in the NKC patients. [36] Majority of graft failures in this study occurred in the first 5 years after surgery. The number of failing grafts reduced gradually reaching a steady state towards the 10 year follow up period (figure iv). Although NKC eyes were more likely to fail compared to KC eyes (p < 0.001), overall survival rates for KC were lower than those reported from most developed countries. [25, 28, 34] It was however surprising to see that NKC eyes had a similar survival rate when compared with what was reported in studies from both developed and developing nations. [18, 25, 28,] In most of these series the 2 year survival rate for KC eyes was well over 90% compared with 81.2% in this series. [35, 37] This was also lower than what was found in the study by Yorston et al in which the survival rate at 2 years was 87%. [3] It was however higher than the survival rate reported in the study from West Bank Gaza in which the survival rate was 79.8%. [6] The 2 year survival rate in the NKC eyes were higher than that reported by Yorston et al which was 64.7% compared with 71.3% in this study. [3] This could be attributed to the improved selection of patients to reduce on eyes with more risk factors for failure in this category of patients.

High risk eyes included MU (OR =6.42), trachoma (OR=6.66), and HSV (OR = 4.44) which together accounted for only 23.6% of all NKC eyes (table 5).The 5 year survival rate for KC (76.3%) was lower than that reported by Dandona et al in a study performed in India were the survival rate at 5 years was 95.1%.[41] A Danish study, by Lomholt et al has reported a 5 year survival rate in NKC eyes of 52%.[36] This was lower than in this study were the 5 year survival rate was 63%.The 10 year survival rate for KC eyes was 72.3% compared with 57% for NKC eyes. Inoue et al reported a 10 year survival rate of 98.8% in KC eyes and an average of 71% for NKC eyes in a study in Tokyo.[35] The results were far higher than what was found in this study. Reasons for this difference could be the optimum conditions for post operative management and follow up of patients in this part of the world. No studies were found looking at more than 5 year graft survival conducted in the third world.

8.8.0 Visual outcome.

KC eyes were more likely to have visual acuities of < 3/60 preoperatively compared with the NKC eyes in the operated eye (p<0.001) (table 13). This outcome was different from what was reported by Yorston et al where NKC eyes were more likely to have preoperative vision of < 3/60 in the operated eye.[3] The reason for this outcome could be that surgery for KC eyes is being delayed until there is no possibility of improving vision by spectacle correction. Some KC patients also already had corneal scars from acute hydrops in the operated eye.

Postoperatively however KC eyes were more likely to have a best corrected visual acuity of 6/18 and better (p=0.003).

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In the study by Yonus et al conducted in Ethiopia, 100% of KC eyes had visual acuity better than 6/60 before correction compared with 37.4% in the NKC group. [23] Similar results were reported in the study by Yorston et al.[3] The KC patients were much more likely to be bilaterally blind (45.1%) preoperatively than the NKC patients (37%) (table 14). This could be attributed to the fact that KC is a bilateral disease.

Owing to the poor outcome in NKC patients, the criteria for choosing patients to benefit from PKP should have included NKC patients only if there were blind in both eyes rather than trying to achieve binocularity. This could have left more grafts for KC patients and would have reduced the failure rate. Only 6 KC patients remained blind after PKP out of 60 patients who were blind pre-operatively, while 20 out of 33 NKC patients remained blind after PKP. There was minimal impact on blindness among the NKC group. In total 93 (41.7%) patients were blind preoperatively. After surgery only 26 (11.7%) of all the patients remained blind. There was therefore a 72% reduction in blindness amongst all the patients who were blind preoperatively. When KC is considered alone, the impact in terms of reducing blindness goes even higher to 90%, compared with 39.4% for NKC cases. This shows that PKP is perhaps more beneficial for KC in our setting.

9.0.0 Conclusions.

1. Keratoconus has the most favorable outcome in terms of graft clarity and postoperative visual acuity after PKP in our setting.

2. The risk for failure is also low for pseudophakic bullous keratopathy and corneal dystrophies.

3. Major causes of blindness in Africa (trachoma and vitamin A deficiency) appear to be unfavorable for PKP due to their high risk for failure.

4. Infections as a complication are more common in the first 2 weeks after PKP and are more likely to cause graft failure than other complications.

5. There is no association with poor outcome by the use for grafting of:

(a) corneal buttons with lower endothelial counts from donors older than 70 years.

(b) corneal buttons with longer storage times.

6. Prolonged cadaveric time at the source of the corneal grafts could be associated with a higher graft failure rate.

7. Use of corneal buttons with smaller size could lead to higher magnitude of postoperative astigmatism.

10.0.0 Recommendations.

1. Given the fact that corneal grafts used in Kenya are currently donated from overseas, priority should be given to KC cases were good outcome and therefore high impact on blindness can be guaranteed.

2. The aim for performing a corneal graft should be treating blindness as defined by WHO, not achieving binocularity.

3. Close follow up in the first 2 weeks is important to look for infections which can contribute to a high failure rate.

4. A study to show the prevalence of KC and other causes of corneal blindness is necessary, to establish the magnitude of the problem.

5. As reliance on donated corneas can not continue indefinitely, establishment of a local eye bank to provide graft materials sourced from local donors would be the way forward.

Limitations of the Study.

The following were the limitations of the study:

1. The poor follow up rate lead to a large number of censored cases in the Kaplan and Meier survival curve.

2. Lack of detailed description of the physical characteristics of the opacified corneal preoperatively in terms of size of scar if any and amount and extent vascularization.

3. The macroscopic and microscopic characteristics were not recorded in majority of the files.

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Appendix A.

Outcome of Penetrating keratoplasty at Kikuyu eye unit carried out from 1993 to 2003.

Questionnaire.

Demographic data.

Name	
Age	
Sex	

Eye operated	RE	LE
Indication		
Date of surgery		

Preoperative assessment.

VA	RE	LE

Ocular disease

	RE	LE
Normal		
Trachiasis		
Ectropion		
Entropion		
Blepharitis		
Allergic conjunctivitis		
Tear film		
Fundoscopy		
ultrasound		
cataract		
IOP		
Pseudophakic		
Aphakic		
Failed graft		
Other 1.		
2.		
3.		

Systemic illness

1.	
2.	
3.	

Intraoperatively

Size of donor button	
Size of recipient site	
Suring technique	
Other procedures done	
1.	
2.	

Postoperatively

Immediate complications

Complication	Timing
Graft opacification	
Wound leak	
Lose sutures	
Flat AC	
Uveal prolapsed	
Hyphaema	
Uveitis	
Infection	
High pressures	
Other	
1.	
2.	
3.	
4.	

Follow up after discharge

Date of review	Status of graft	Removal of sutures	complications	VA

Latest refraction after removal of sutures

	sphere	Cylinder
RE		
LE		

Best corrected visual acuity.

RE	LE

If graft failure, is it

Primary	
Or secondary failure	

What is the cause of failure?

Details of the graft.

Age of donor	
Endothelial count	
Cadaveric time	
Storage time	
Source of graft	
Storage media.	

Appendix c.

WHO categories of visual impairment[24]

Category	Visual Acuity with BCVA in the better eye	Degree of visual Impairment
0	6/6 – 6/18	Normal Vision
1	<6/18 – 6/60	Visual Impairment
2	<6/60 – 3/60	Severe visual impairment
3	<3/60 – 1/60	Blind
4	<1/60 – Light perception	Blind
5	No light perception	Blind
6	Undetermined of unspecified	

If the extent of visual field is taken into account, patients with a field not greater than 10^{0} but greater than 5^{0} around central fixation should be placed in category 3 and patients with a field no greater than 5^{0} around central fixation should be placed in category 4, even if visual acuity is not impaired.