PHILIPPINE JOURNAL OF
Ophthalmology

VOL. 30 • NO. 4 OCTOBER - DECEMBER 2005

ORIGINAL ARTICLE

# Indications for penetrating keratoplasty in the Philippines

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## ABSTRACT

**Objective**

To determine the indications for penetrating keratoplasty (PKP) in the Philippines.

**Method**

This is a retrospective review of data collected by the Sta. Lucia International Eye Bank Foundation (SLIEBF) of Manila based on postoperative reports of penetrating keratoplasty.

**Results**

A total of 2,131 postoperative reports from 1996 to 2004 were reviewed. The average age of recipients was 47.2 years. The age distribution was bimodal, with peaks at 35 to 45 years and at 65 to 75 years. The leading indications for PKP were corneal scars (23.9%), pseudophakic bullous keratopathy (PBK) (19.7%), microbial keratitis (17.6%), regrafts (9.8%), and aphakic bullous keratopathy (ABK) (5.6%). Indications for PKP showed increasing trend for regraft and decreasing trend for corneal scar. Trauma, microbial keratitis, and corneal scar were more common among males while Fuch's dystrophy, corneal stromal dystrophy, PBK, and glaucoma causing bullous keratopathy were more common among females. Corneal scar, microbial keratitis, and viral infection were frequently seen among those in the lower socioeconomic groups while PBK, ABK, regraft, Fuch's, and keratoconus were seen among more affluent patients.

**Conclusion**

Corneal scar, PBK, and microbial keratitis were the leading indications for PKP in the Philippines from 1996 to 2004. There was an increasing trend toward regraft and a decreasing trend for corneal scar during the period.

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No financial assistance was received for this study.

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***Keywords:*** *Penetrating keratoplasty, Corneal transplantation, Corneal scar, Bullous keratopathy, Keratitis, Fuch's dystrophy*

PHILIPP J OPHTHALMOL 2005; 30(1): 148-152

CORNEAL transplantation has become one of the most successful procedures in organ transplantation in the past six decades. Though this success is attributable to the relative immune privilege naturally inherent to the cornea and to advances in surgical techniques and instrumentation, it is also largely the establishment of reliable eye banks around the world that resulted in increased availability and better quality of donor corneal tissues.

In areas of the world with established eye banks where penetrating keratoplasty (PKP) has become a routine procedure, the indications for PKP and the changing trends of those indications have been well studied.[1-6] In the Philippines, however, this information is lacking.

Prior to the founding of the Eye Bank Foundation of the Philippines and the subsequent opening of its eye bank, the Santa Lucia International Eye Bank of Manila (SLIEB), PKP had been performed sporadically using eyeballs harvested from cadavers and stored in make-do moist chambers and the corneal buttons occasionally donated from abroad. Since its establishment, the SLEBIF has become the major source of transplantable corneal tissues for medical institutions and private clinics in the Philippines, with PKP becoming a routine procedure. This study determined the leading indications for PKP in the Philippines using records of the SLIEBF and compared these indications with those of other countries.

## METHODOLOGY

Each donor corneal button distributed to a surgeon or medical institution by the SLIEBF was accompanied with a request for the following information: (1) surgeon/institution performing the PKP; (2) general recipient information, such as age and sex, medical and ophthalmic history; and (3) type of procedure performed (i.e. whether combined with cataract extraction, etc). This postoperative report became part of the SLIEBF database.

Postoperative reports returned to the SLIEB from January 1, 1996 to December 31, 2004 were reviewed. The indications for PKP were tabulated annually and cumulatively over a nine-year period. The same nomenclature was used to facilitate comparison with other published studies.

Categories of indications listed were the following: pseudophakic bullous keratopathy (PBK), aphakic bullous keratopathy (ABK), Fuch's dystrophy, corneal dystrophies, keratoconus, corneal scar, microbial keratitis, viral infection, noninfectious keratitis, trauma, regraft, Steven Johnson Syndrome, congenital defect, and glaucoma.

Corneal scar included those due to unspecified causes, whether from previous inflammation or infection or old ocular trauma. Regraft, whether due to graft rejection or failure, was given priority over all other diagnoses regardless of the primary indication for PKP. Intraocular lens implants (IOLs) included both anterior- (AC) and posterior-chamber (PC) lenses. Microbial keratitis included both active and old microbial cases. Viral infection included herpes simplex keratitis and measles-associated infections. Causes of trauma were chemical, mechanical, or thermal injuries. Corneal dystrophies included dystrophies other than Fuch's dystrophy. Miscellaneous causes were listed under "others". Those without any indication were listed under "unspecified".

Demographic data of the recipient included age, sex, and socioeconomic status (i.e. charity when the patient was operated in a training institution with reduced fees versus pay when the patient paid the regular processing fees). For each indication for PKP, the differences in gender and socioeconomic conditions were analyzed using Chi-square test. A $p$ value less than 0.05 was considered significant.

## RESULTS

SLIEBF processed a total of 6,225 corneal tissues from January 1996 to December 2004. Of these, 1,265 could not be used due to positive serologic testing, mostly for active hepatitis B (971 or 76.8% of serologically unfit tissues). A total of 4,074 corneal tissues were used for optical PKP, of which 2,874 (70.5%) were distributed to 109 institutions and ophthalmologists in the Philippines and 1,200 (29.5%) to 24 other countries. The remaining corneas were set aside for tectonic use, research, or were found unsuitable for surgery due to coexisting medical conditions.

Of the 2,874 corneas distributed locally, 2,131 postoperative reports were obtained (retrieval rate of 74.1%) and reviewed for inclusion into the study.

The age of the recipients requiring PKP ranged from 2 months to 96 years old, with a mean of 47. 2 years. A bimodal distribution with peaks at age groups 35 to 45 and 65 to 75 years was seen (Figure 1). 59.5% of the recipients were males and 53.8% belonged to the lower socioeconomic status.

The main indications for PKP were corneal scar, PBK, microbial keratitis, regraft, and ABK (Table 1). These top 5 indications accounted for 76.6% of cases.

Yearly tabulation of the top 5 indications for PKP showed PBK peaking from 1996 to 1998 and going down thereafter. There was an increasing trend for regraft since the middle of 2001, and a decreasing trend for corneal scar (Figure 2).

As indications for PKP, corneal scar, microbial keratitis, and trauma were 74%, 60%, and 33% respectively more common in males than females (Table 2). PBK, Fuch's dystrophy, corneal stromal dystrophy, and glaucoma causing bullous keratopathy were more frequent among females. In particular, Fuch's, stromal dystrophy, and

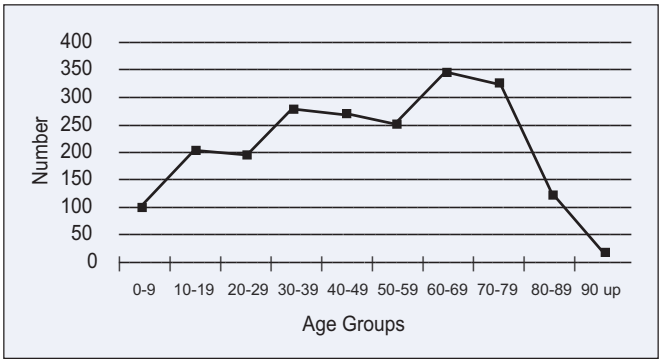


**Figure 1**. General age distribution of corneal recipients, 1996–2004.

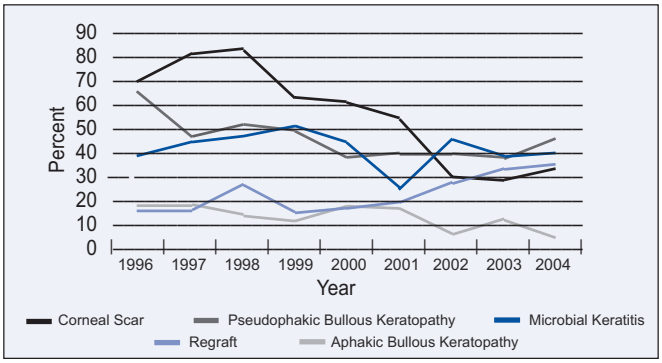


**Figure 2**. Trends of top five indications for penetrating keratoplasty, 1996–2004.

Table 1. **Indications for penetrating keratoplasty in the Philippines, 1996-2004.**

| Indications | Number | Percent |
|---|---|---|
| Corneal scar | 509 | 23.9 |
| Pseudophakic bullous keratopathy | 420 | 19.7 |
| Microbial keratitis | 376 | 17.6 |
| Regraft | 208 | 9.8 |
| Aphakic bullous keratopathy | 120 | 5.6 |
| Fuch's dystrophy | 110 | 5.2 |
| Viral infection | 91 | 4.3 |
| Trauma | 60 | 2.8 |
| Corneal dystrophy | 57 | 2.7 |
| Glaucoma | 44 | 2.1 |
| Keratoconus | 41 | 1.9 |
| Congenital defect | 29 | 1.4 |
| Noninfectious ulcerative keratitis | 19 | 0.9 |
| Steven Johnson syndrome | 8 | 0.4 |
| Others | 23 | 1.1 |
| Unspecified | 16 | 0.8 |
| **Total** | **2,131** | **100.0** |

Table 2. **Gender and socioeconomic status as factors predictive of penetrating keratoplasty.**

| Indications | Gender | | | Socioeconomic status | | |
|---|---|---|---|---|---|---|
| | OR | *p* | CI | OR | *p* | CI |
| Corneal scar | 0.74 | 0.004 | 0.60; 0.91 | 0.53 | <.001 | 0.43; 0.66 |
| Pseudophakic bullous keratopathy | 1.44 | 0.001 | 1.16; 1.79 | 2.16 | <.001 | 1.73; 2.71 |
| Microbial keratitis | 0.61 | <.001 | 0.47; 0.78 | 0.32 | <.001 | 0.24; 0.42 |
| Regraft | 0.96 | 0.76 | 0.70; 1.29 | 1.94 | <.001 | 1.44; 2.64 |
| Aphakic bullous keratopathy | 1.33 | 0.13 | 0.90; 1.95 | 1.94 | <.001 | 1.31; 2.91 |
| Fuch's dystrophy | 2.47 | <.001 | 1.64; 3.77 | 2.30 | <.001 | 1.51; 3.55 |
| Viral infections | 0.88 | 0.55 | 0.55; 1.38 | 0.52 | 0.004 | 0.32; 0.83 |
| Trauma | 0.33 | 0.001 | 0.15; 0.65 | 1.33 | 0.27 | 0.77; 2.31 |
| Stromal dystrophy | 2.02 | 0.008 | 1.15; 3.60 | 0.91 | 0.73 | 0.51; 1.60 |
| Glaucoma | 2.33 | 0.005 | 1.22; 4.59 | 2.04 | 0.02 | 1.06; 4.06 |
| Keratoconus | 0.85 | 0.61 | 0.41; 1.67 | 3.61 | <.001 | 1.71; 8.30 |
| Congenital defects | 1.19 | 0.64 | 0.53; 2.66 | 1.25 | 0.55 | 0.56; 2.81 |
| Noninfectious keratitis | 1.07 | 0.89 | 0.37; 2.93 | 1.05 | 0.92 | 0.38; 2.89 |
| Steven Johnson syndrome | 2.45 | 0.21 | 0.47; 15.8 | 0.39 | 0.23 | 0.04; 2.18 |
| Others | 2.75 | 0.02 | 1.09; 7.53 | 1.52 | 0.32 | 0.61; 3.88 |
| Missing data | 0.67 | 0.45 | 0.18; 2.09 | 1.50 | 0.42 | 0.49; 4.75 |

glaucoma as indications for PKP were 2 times more likely to be seen in females (Table 2).

Corneal scar, microbial keratitis, and viral infection were the more frequent indications among the lower socioeconomic (charity) group, while PBK, ABK, regraft, Fuch's, glaucoma, and keratoconus were the more common indications among the higher socioeconomic group (Table 2). Among pay patients, the conditions cited were almost 2 times more common, with the exception of keratoconus which was 3.5 times.

## DISCUSSION

The leading indications for PKP in the developed world are PBK, regraft, and keratoconus,[1-6] in contrast to developing countries like India, Taiwan, Israel, and China[9-12] where the most common indications are corneal scar and microbial keratitis. The results of this study were very similar to those of studies in the developing world, with an overall rate of greater than 20% and 10% for corneal scar and microbial keratitis respectively (Table 3).

Corneal scar and microbial keratitis together made up 40.5% of all indications for PKP in this study. From 1971 to 1991, the most common condition treated at the Cornea and External Disease Section of the Department of Ophthalmology, University of the Philippines-Philippine General Hospital was microbial keratitis.[14] Most of the infectious corneal ulcers ended up in significant scarring of the cornea. Both conditions were also more common among patients of lower socioeconomic status (Table 2), similar to the results found in India.[9] This may reflect the fact that poor patients have less resources for proper medical treatment and limited access to immediate care, especially in the rural areas. Conversely, microbial keratitis and corneal scar were less common among wealthy patients who were more likely to seek immediate care before the condition worsened and caused significant visual impairment. Approximately 50% of the infectious keratitis in this study were fungal in etiology which was associated with vegetable-matter injury,[15,16] commonly seen

among poor farmers in the Philippines.

Figure 2 shows that the incidence of corneal scar peaked during the years 1996 to 1998 with a gradual decrease thereafter. The high numbers of PKP done for corneal scar in the early years of the eye bank may be a reflection of the backlog of these cases prior to the establishment of the eye bank, and which decreased once corneas became more available.

PBK was the second leading indication for PKP in this study at 19.7%, with peaks from 1996 to 1997 reflecting a backlog and stabilization thereafter (Figure 2). Other studies also showed incidences greater than 10%,[1, 3-12] except for the UK study where its relatively low percentage of 7.6% was attributed to a more conservative approach and slower acceptance of intraocular lenses[2] during the period of the study.

The age distribution in this study was bimodal, with peaks at two age groups; the first at 35 to 45 years due to corneal scars and microbial keratitis, and the second at 65 to 75 years due to PBK (Figure 1). This distribution fits the age group (20 to 50 years) when microbial keratitis is usually found,[15] and the elderly group when PBK and cataract are higher. This bimodal distribution was also seen in other studies.[1, 6]

The rate of regraft (9.8%) in this series was considerably lower than those reported in developed countries where incidences approached 20% or more (Table 3). From 2001 onwards, however, there was a steady increase, a reflection of the increasing number of PKPs performed over time and the potential for graft failure,[10] a trend similar to those of other studies.[10, 17, 18]

Fuch's dystrophy was more common among females in this study, consistent with well-known epidemiological data on Fuch's.[19]

In developed countries, keratoconus is one of the leading indications for PKP, unlike in developing countries in Asia including the Philippines where the incidence is much lower (Table 3). The reason for this difference is not clear. Mamalis et al.[4] suggested that there may be a higher incidence of keratoconus among Caucasians, particularly those from Northern Europe or Scandinavia.

PBK, ABK, regraft, Fuch's dystrophy, and keratoconus as indications for PKP were more common among those belonging to the higher socioeconomic status. This can be attributed to the fact that poorer patients treated at training institutions were more likely to delay surgery due to financial constraints and likely to tolerate the blurry vision longer. Wealthier patients have greater access to expert care and were more likely to have the conditions treated earlier.

Trauma as a cause for PKP is much more common among males, as reported in both foreign and local studies.[15, 20, 21] Males have been shown to be at higher risk for traumatic eye injury in occupational and recreational settings[15] and are associated with higher incidences of microbial keratitis and corneal scar. Valenton found that trauma was the predisposing factor in 75% of bacterial and fungal keratitis and that manual laborers, farmers, and construction workers were particularly vulnerable. In our study, microbial keratitis and corneal scar were seen more frequently among poorer patients while trauma was not associated with socioeconomic status. Possible explanations include the type of surgery done—most of the poorer patients may have opted for cheaper surgical treatments such as primary repair or tectonic grafts instead of PKP.

Viral infections were also more common among the charity patients undergoing PKP. Though timely medical treatment with topical and oral antiviral medications may provide cure, patients with fewer funds and less access to expert care may have poorer control of the disease process leading to significant corneal scarring.

The top 5 indications for PKP in this study have relatively poorer prognosis due to the associated neovascularization and active inflammation commonly present that are well-known risk factors for graft failure.[19] This is in contrast to keratoconus as a leading indication in developed countries with better prognosis. Regraft as an

Table 3. **Comparison of leading indications (in percent) for penetrating keratoplasty.**

| | Padilla, Philippines 1996-2004 n = 2,131 | Wei-Li Chen,[10] Taiwan 1987-1999 n = 770 | Dandona,[9] India 1987-1995 n = 1,964 | Zhang,[12] China 1994-2003 n = 229 | Liu,[3] Canada 1986-1995 n = 904 | Edwards, Zealand 1991-1999 n = 1,370 | Al-Yousuf,[2] UK 1990-1999 n = 784 | Maeno,[1] Canada 1964-1997 n = 6,222 | Mamalis,[4] USA 1981-1990 n = 999 |
|---|---|---|---|---|---|---|---|---|---|
| Corneal scar | 23.9 | 27.9 | 28.1 | 55.9 | 2.9 | --- | --- | --- | 8.2 |
| PBK | 19.7 | 17.6[a] | 10.6 | 12.2[a] | 28.5 | 17.9[a] | 7.6 | 15.3 | 23.0 |
| Microbial Keratitis | 17.6 | 17.9[b] | 12.2 | 12.2 | 4.3 | 3.3 | --- | --- | 5.7 |
| Regrafts | 9.8 | 21.0 | 17.1 | 10.5 | 22.3 | 8.7 | 40.9 | 18.0 | 13.1 |
| ABK | 5.6 | [a] | 11.8 | [a] | 6.2 | [a] | --- | --- | 5.6 |
| Fuch's Dystrophy | 5.2 | 4.5 | --- | --- | 7.7 | 4.4 | 9.3 | 9.6 | 5.8 |
| Keratoconus | 1.9 | 2.5 | 6 | 5.7 | 10 | 45.6 | 15 | 16.0 | 24.2 |

[a]indicates percentage of PBK and ABK combined
[b]includes all causes of necrotizing and ulcerative keratitis

indication for PKP is, therefore, likely to increase.

In summary, corneal scar was the most frequent indication for PKP in the Philippines from 1996 to 2004, followed by PBK and microbial keratitis. Those belonging to the lower socioeconomic sector were more likely to have corneal scar, microbial and viral infection while wealthier patients were more likely to have keratoconus, PBK, ABK, and Fuch's dystrophy. Regraft as an indication for PKP has also increased since 2001.

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**Acknowledgement**

The authors gratefully acknowledge the statistical assistance of Dr. Marie Carmela Lapitan of the Department of Urology, Philippine General Hospital.