

# Indications for Corneal Transplantation in New Zealand: 1991–1999

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**Purpose.** To identify the indications for keratoplasty in patients supplied with donor tissue through the New Zealand National Eye Bank. **Methods.** Analysis of penetrating and lamellar keratoplasty data collected by the New Zealand National Eye Bank, Auckland, from 1991 to 1999. **Results.** In this 9-year period, donor material was supplied for 1370 corneal grafts; 1308 for penetrating keratoplasty, 26 for lamellar keratoplasty, and 36 for unspecified grafts. This accounts for a minimum of 85% of the penetrating keratoplasties performed in New Zealand from 1991 to 1999. The leading indications for penetrating keratoplasty were keratoconus (45.6%), pseudophakic or aphakic corneal edema (17.9%), regrant (8.7%), viral keratitis (7.3%), and trauma (5.5%). The average age of patients was 47.5 years (SD = 22.6) and age distribution was bimodal, with peaks in the 3rd and 8th decades. Keratoconus, regrant, and trauma were significantly more common as indicators for penetrating keratoplasty in male patients than female patients; however, pseudophakic or aphakic corneal edema was more common in female patients. **Conclusion.** The majority of transplantation surgery in New Zealand is performed using corneal tissue from the New Zealand National Eye Bank. In this representative study, keratoconus is the leading indicator for penetrating keratoplasty in New Zealand, accounting for a higher proportion than in any other published literature. The other indications, age distribution and gender differences correlate with previous reports. These findings suggest that keratoconus leading to transplantation may have increased prevalence in New Zealand.

**Key Words:** Corneal Transplantation—Penetrating keratoplasty—Corneal Graft—Indications—Keratoconus—Eye bank.

The New Zealand National Eye Bank (NZNEB) began using organ culture techniques for the storage of corneal tissue in 1991. Since then it has maintained a comprehensive prospective database, supported by New Zealand ophthalmic surgeons, in relation to all tissue provided for corneal transplantation. Although exact figures are unavailable, it is known that the NZNEB has provided more than 85% of the donor tissue during this period. As such, its records are representative of the nature of corneal disease and demographics of keratoplasty in New Zealand. Our study used this

database to determine patient characteristics and indications for corneal graft from 1991 to 1999.

## MATERIALS AND METHODS

As part of a large, longitudinal, prospective study, the electronic records of the NZNEB for the 9-year period 1991 to 1999 were analyzed for each year with respect to age, sex, indications for and type of corneal transplantation, and associated surgical procedures. The indication for keratoplasty was the clinical diagnosis given by the surgeon at the time of surgery. Where more than one clinical diagnosis was identified the priority scheme suggested by Brady et al. was applied.<sup>1</sup> In particular, the diagnosis of regrant was given priority over all other diagnoses, and when available, the indication for, and number of previous grafts was recorded.

## RESULTS

During the study period, donor material was supplied for 1370 corneal grafts; 1308 for penetrating keratoplasty (PKP), 26 for lamellar keratoplasty (LKP) and 36 where the type of graft was not specified. The numbers of grafts performed in each year is shown in Figure 1. The leading indications for PKP were keratoconus (45.6%), pseudophakic or aphakic corneal edema (17.9%), regrant (8.7%), viral keratitis (7.3%) and trauma (5.5%). Figure 2 illustrates the distribution of grafts for these conditions over the study period. The five aforementioned disorders comprise 85% of the indications for PKP: the other indications are shown in Table 1. Only 1.3% of indications for PKP were not specified.

The sex distribution of patients having undergone PKP was 685 (52.4%) male, 561 (42.9%) female, 62 (4.7%) unspecified. For the five leading indications, the odds ratios for having a specific indication, given a specific sex, are shown in Table 2. Keratoconus, regrant, and trauma were significantly more common indications in men, and aphakic and pseudophakic corneal edema were more common in women. Additionally, PKP for Fuchs' endothelial dystrophy was significantly more common in women ( $n = 39$ ) than men ( $n = 15$ ) ( $p < 0.001$ ).

The average age of patients having PKP was 47.5 years, with a standard deviation of 22.6 years. The average age in each year of the study varied between 44.2 and 50.3 years, with no clear trend. Age distribution showed a bimodal pattern with peaks in the 3rd and 8th decades (Fig. 3). Average ages at the time of surgery for the five main diagnostic groups were; keratoconus, 31.8 years;

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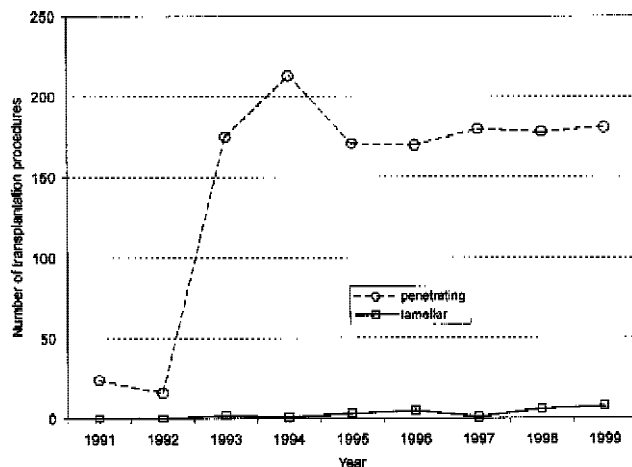


FIG. 1. Number of transplantation procedures, penetrating and lamellar keratoplasty, for the years 1991-1999.

pseudophakic or aphakic corneal edema, 72.3 years; regrant, 52.7 years; viral keratitis, 54.4 years; and trauma, 40.2 years. Male patients with keratoconus were significantly younger at the time of surgery (30.3 years) than females (33.8 years,  $p < 0.004$ ). Females having PKP for corneal edema after cataract surgery (pseudophakic and aphakic) were significantly older (74.7 years) than males (69.9 years,  $p < 0.005$ ).

The trends in corneal transplantation for aphakic or pseudophakic corneal edema and Fuchs' endothelial dystrophy are shown in Figure 4. Unfortunately, the data for subjects undergoing regrants did not contain adequate information about the indication for primary graft to calculate risk ratios for regrant.

The NZNEB is the major supplier of tissue for PKP, providing the vast majority of donor tissue in the period studied. One center, Auckland, performed the greatest number of PKPs during this period (36.2%), but PKPs were performed widely throughout New Zealand at 13 principal centers that carried out between 3 (0.2%) and 163 (12.5%) PKPs. Only one center, Christchurch, used tissue for PKP from other sources during the entire study period (this center sourced donor tissue locally and used short-term storage techniques). This center now uses donor tissue from NZNEB. Based on current usage of tissue supplied to Christchurch, plus unfulfilled demand for donor tissue elsewhere in New Zealand in the

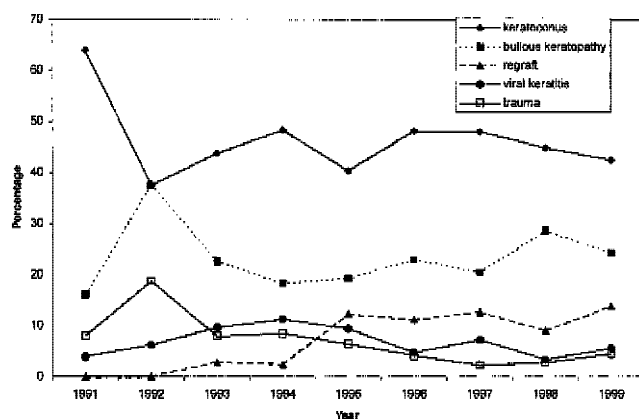


FIG. 2. Relative indications for penetrating keratoplasty for the five most common diagnostic categories, 1991-1999

TABLE 1. Indications for penetrating keratoplasty in New Zealand, 1991-1999

Diagnosis	Number of cases	%
Keratoconus	597	45.6
Pseudo/aphakic corneal oedema	235	17.9
Regrant	114	8.7
Viral keratitis	96	7.3
Trauma (mechanical & chemical)	72	5.5
Fuchs' endothelial dystrophy	58	4.4
Stromal dystrophies	53	4.0
Other infective keratitis	43	3.3
Other non-infective keratopathy	16	1.2
Degenerations	9	0.7
Other	90	7.0
Not specified	18	1.3

first two years of the NZNEB (calculated from donor tissue utilization in year 3 and subsequent years), by extrapolation it is estimated that NZNEB supplied a minimum of 85% of donor tissue during the study period.

## DISCUSSION

New Zealand (Aotearoa) is a moderately sized country of 103,415 square miles with a small population of 3.75 million and a cohesive, if widely distributed, ophthalmic community. Ophthalmologists in New Zealand generally spend at least 6 years training in ophthalmology with the majority undertaking subspecialty Fellowship training. Excluding residents and fellows, there are 98 ophthalmologists in New Zealand with approximately 10% having subspecialty training in cornea and anterior segment surgery. There are also more than 430 registered optometrists in New Zealand and therapeutic contact lenses are provided by both Hospital-based and community services.

Approximately 175 PKPs are performed each year and the New Zealand National Eye Bank was established in 1991 to support this demand. Since 1993 the number of PKPs performed annually using material from the NZNEB has remained relatively constant. The five main indications (keratoconus, pseudophakic or aphakic corneal edema, regrant, viral keratitis and trauma) are frequently cited as leading indications in published studies, but their relative proportions in New Zealand appear unique. Table 3 compares indications from this study with three other reports from different continents over the last decade. In particular, the proportion of PKPs for keratoconus is significantly higher than in other published reports. Over the last 10 years, sources from outside Australasia quote the proportions of PKPs performed for keratoconus as between 7 and 24%.<sup>2-10</sup> Two reports from Australia have demonstrated a higher proportion of keratoconus, at 31%<sup>11</sup> and 37%.<sup>12</sup>

TABLE 2. Gender differences in indication for PKP in New Zealand 1991-1999

Indication	Male (%)	Female (%)	Odds ratio
Keratoconus	349 (50.9)	223 (39.8)	1.57 ( $p < 0.001$ )
A/P corneal oedema	95 (13.8)	124 (22.1)	0.57 ( $p < 0.001$ )
Regrant	69 (10.1)	39 (7.0)	1.50 ( $p < 0.048$ )
Viral keratitis	43 (6.3)	49 (8.7)	0.70
Trauma	58 (8.5)	12 (2.1)	4.23 ( $p < 0.001$ )

A/P corneal oedema indicates aphakic or pseudophakic corneal oedema.

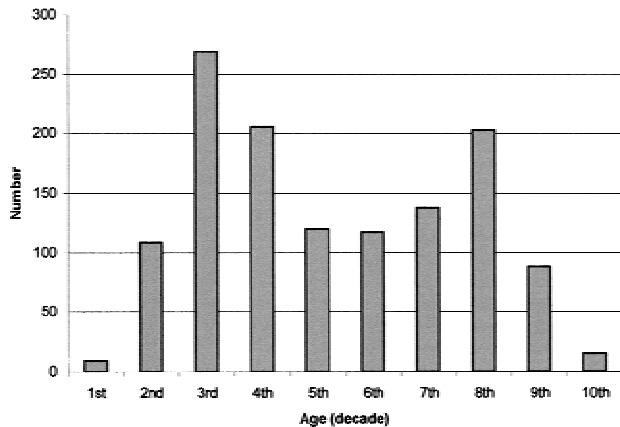


FIG. 3. Total number of penetrating keratoplasties plotted against decade of age, highlights a bimodal distribution

Although it is the clinical impression of corneal surgeons that keratoconus is unusually common in New Zealand, especially in Maori and Pacific Island communities, there is little prior data to confirm this. Indeed, one earlier study (1978) reported a prevalence rate of 1 in 2000 around Hawkes Bay in the North Island.<sup>13</sup> There are several other possible explanations for keratoconus being such a common indication for PKP in the current study. First, the other indications for PKP may be disproportionately low. Reference to other studies shows that, with the exception of corneal edema after cataract surgery as an indication for PKP in the USA, this is unlikely (Table 3). Second, keratoconus in New Zealanders may progress more rapidly to a stage requiring PKP compared with other populations. A recent study in Britain has demonstrated a four-fold increase in prevalence of keratoconus in Asians compared with Caucasians living in the same geographic area.<sup>14</sup> The same study confirmed findings from other studies that show differences in severity and rate of progression for different ethnic groups.<sup>15,16</sup> Unfortunately, until recently, the NZNEB records have not contained accurate details on the ethnic origin of recipients. Interestingly, the proportion of PKPs for keratoconus in Auckland (38.5%), the largest Polynesian city in the world, is not significantly higher than the rest of the country (36.2%). However, the relative under-use of NZNEB tissue by Christchurch, the largest city in the South Island, may have slightly distorted these figures.

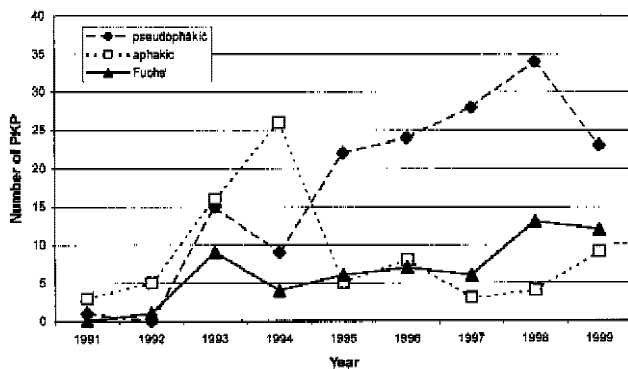


FIG. 4. Relative indications for penetrating keratoplasty 1991–1999, comparing pseudophakic bullous keratopathy, aphakic corneal edema, and Fuchs' endothelial dystrophy.

TABLE 3. Comparison of indications for penetrating keratoplasty (%)

Indication	Cursiefen et al <sup>2</sup> Germany (1992–1996)	Lois et al <sup>7</sup> USA (1989–1995)	Wong et al <sup>10</sup> Singapore (1991–1995)	Current study New Zealand (1991–1999)
Keratoconus	20.9	13.2	9.8	45.6
A/P corneal oedema	17.0	26.0	22.9	17.9
Regraft	15.5	17.8	11.9	8.7
Viral keratitis	—	3.6	4.0	7.3
Trauma	3.2	2.3	10.1	5.5

A/P corneal oedema indicates aphakic or pseudophakic corneal oedema.

In New Zealand, keratoconus that requires PKP has a significant male preponderance. In addition, male patients were significantly younger at the time of surgery than female patients. Whether keratoconus is more common in men, or, as postulated by Damji et al,<sup>17</sup> they have a more aggressive disease requires further investigation.

The age distribution of subjects undergoing PKP by decade fits well with other descriptions of bimodal spread,<sup>8</sup> the larger first peak in this study represents keratoconus, the second peak, corneal edema after cataract surgery. In New Zealand, the average age of patients undergoing PKP seems stable, probably because of the high proportion of keratoconics.

The percentage of PKPs performed for pseudophakic corneal edema displays an increasing trend, as PKP for aphakic corneal edema is decreasing. These trends reflect changing surgical technique. Whether modern implant technology reduces the percentage of grafts for pseudophakic corneal edema, perhaps seen in figures for 1999 of the study, remains to be seen. Our observations confirm those of Maeno et al, that corneal edema after cataract surgery is more common in women than men.<sup>8</sup> This reflects epidemiological data showing that Fuchs' endothelial dystrophy, a predisposing factor, is more common in women,<sup>18</sup> and more likely to manifest with corneal edema because of their greater life expectancy. This study shows that in the absence of previous cataract surgery Fuchs' endothelial dystrophy requiring PKP was 2.6 times more common in women than men. The latter finding is reflected by the greater age of female patients at the time of PKP after cataract surgery.

Interestingly, in the middle year of the current study (1995), comparative data from the Eye Bank Association of America (EBAA) ranked indications for penetrating keratoplasty as: non-specified (21.5%), pseudophakic corneal edema (20.5%), corneal ectasias/thinning (12.3%), and endothelial corneal dystrophies (11.9%); whereas, combined indications for regraft totalled 10.4% and aphakic corneal edema 5.6%.<sup>20</sup> Although the overall rate of PKP in this study is lower than might be anticipated for the population of New Zealand, as a percentage of overall indications for PKP during 1991–99, combined pseudophakic and aphakic bullous keratopathy (17.9%) is much lower than that recorded by the EBAA (26.1%). In contrast, in the absence of public healthcare restrictions or surgeon preference for cases with better visual potential (e.g. keratoconus), nor significant limitation on donor tissue availability, keratoconus as an indication for PKP appears to be almost 4-fold greater in this New Zealand study than in the EBAA data (although comparison is limited by the 21.5% unspecified cases and the higher indication for PKP in pseudophakic/aphakic corneal edema in the EBAA statistics.).

The significant male predominance for ocular trauma in relation to PKP has been described previously,<sup>19,21</sup> and is well demonstrated in our population.

The New Zealand National Eye Bank supplies more than 85% of donor material for corneal transplantation throughout New Zealand. In addition to providing donor tissue, the prospective compilation of study data provides an accurate reflection of national disease patterns. In particular, they confirm the high prevalence of keratoconus as an indication for surgery in New Zealand; the reason for this is the subject of ongoing studies.

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