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GAUTENG CORNEA AND EYE BANK REGISTRY-

A REPORT ON CORNEAL GRAFTS DONE BETWEEN

JANUARY 1998 AND DECEMBER 2005.

Dr Aubrey Makgotloe

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Ophthalmology.

Johannesburg, 2009

DECLARATION

I, Aubrey Zacharia Makgotloe, hereby declare that this research is my own unaided work. It is being submitted for the degree of Master of Medicine in the branch of Ophthalmology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

.....

..... Day of 2009

DEDICATION

To my wife, Boitumelo, for her support throughout the writing period.

To my daughter, Reabetswe Safi Makgotloe, for making me very happy.

To my mother, Berlina Makgotloe, for raising me to be what I am today.

To my brothers, Itumeleng and Tshepo, for being such good brothers.

To my uncles, Molefi and Pule, for being such exemplary guardians.

AWARDS AND PRESENTATIONS

The Ophthalmological Society of South Africa award for the best Registrar presentation

The Ophthalmological Society of South Africa congress

Sun City

South Africa 2004

Presenter: Aubrey Makgotloe

ABSTRACT

Aim: To describe and analyse donor demographics; source, utilisation and distribution of corneal tissue procured by the Gauteng cornea and eye bank (GCEB). To further establish the indications for penetrating keratoplasty done by private ophthalmologists in Johannesburg.

Methods: A retrospective study of the records from the GCEB for the 8 year period from 1998 to 2005. An analysis for each year was done in respect of donor demographics; corneal donor tissue source and distribution. Records from selected corneal surgeons in private practice in Johannesburg were analysed for indications for penetrating keratoplasty.

Results: During the study period, 2504 corneas were retrieved from 1252 donors. The average number of donors per year was 157 (Standard deviation: 20.01). There was a statistically significant increase in the number of donors over the study period (B-coefficient = 6.40, standard error=2, 07, p-value=0.02). Majority of donors were males (68.6%). The mean age of donors was 40.4 years (Standard deviation: 15.97) and ranged from 3 months to 78 years. Whites were in overwhelming majority compared to other races, accounting for 96% (number=1205), followed by Blacks 2% (number=24), Asians 1% (number=18) and Coloureds <1% (number=5). The proportion of donated corneas used for transplantation (corneal utilisation rate) averaged 87%. This rate showed a significant decline over the period studied (B-coefficient= -1.76, standard error=0.48, p-value=0.01). The commonest reason for discarding corneas was damaged corneas (36%), followed by Human immunodeficiency virus infection (18%) and inconclusive blood results (14%). The majority of donated corneas were used in private practices (91%).

The majority of donors were referred by mortuaries (50%) and private hospitals (37%). The commonest indication for penetrating keratoplasty was keratoconus (46.8%), followed by corneal scarring (27.8%) and pseudophakic bullous keratopathy (10.1%)

Conclusions: This analysis shows that the number of donors increased annually over the study period. There were very few Blacks donating corneas in Johannesburg and most of the referrals were from mortuaries and private hospitals. The distribution of corneal tissue in areas served by the Gauteng cornea and eye bank is in favour of private hospitals. Corneal tissue damage and HIV infection were the commonest reasons for discarding corneas. In private practices in Johannesburg, keratoconus was the commonest indication for penetrating keratoplasty, followed by traumatic corneal scarring.

PREFACE

Gauteng cornea and eye bank (GCEB) was established in 1995 under the joint sponsorship of the Ophthalmological Society of Southern Africa, The Lions fight-for-sight Foundation and Clinic Holdings. Its main responsibility is to collect donor eyes from suitable donors, process and store them. It then makes these eyes available for ophthalmologists' use in the private and public sectors, mostly in the Johannesburg area of Gauteng.

The decision to study the GCEB registry came after the realisation that since its inception in 1995, no study has ever been done on it. As a result, no information is publicly available on the extent of the shortage or need for donor corneas in Gauteng. Such information is valuable in helping the healthcare policy-makers and clinicians when planning eye-care services in Gauteng.

I reviewed literature on similar studies from other parts of the world so that comparison can be made with other eye banks. These studies show that appropriate procurement programs initiated by eye banks can eliminate donor corneas shortage.

The fact that GCEB makes corneas available to both the private and public sectors and that these sectors have different funding schemes, makes it imperative that information be sought on the distribution of corneas between these two sectors. Equitable distribution of resources (corneas), which has become important in this country, will rely on the availability of such information.

The commonest indications for corneal graft in most developed countries are keratoconus and pseudophakic bullous keratopathy. Corneal scarring remains the leading indication in developing

countries. This study will also report on the indications for corneal graft in areas served by GCEB and compare them with those from elsewhere in the world.

This study is an extension of a study done on the GCEB registry which analysed the data from 1998 (when formal records were first available from the eye bank) to 2000. The study was started by me and Dr Rajen Pillay in 2001. In this initial study, data were collected from the GCEB and selected corneal surgeons in Johannesburg (arbitrarily defined as those having done 15 or more corneal grafts from the year 1998 to 2000). I presented the results of that study in 2004 at the Ophthalmological Society of Southern Africa congress for which a prize was awarded for the best registrar presentation. I have since decided to extend the study to include the years 2001 to 2005 for the MMed project.

ACKNOWLEDGMENTS

1. I am greatly thankful to my supervisor, Prof T R Carmichael, for his continuous support. His understanding and encouragement have prevented me from giving up on numerous occasions. His dedication to work and professionalism will continue to encourage me for many years to come. The Division of Ophthalmology at Wits is very fortunate to have him as head.
2. Thanks to Lynne Pickering and Antoinette van Zyl for helping me during data collection at the eye bank.
3. Thanks to all the ophthalmologists who allowed me to use data from their practices.
4. Thanks to Dr Raj Pillay for suggesting that I do a project on the eye bank.
5. Thanks to Dr Clive Martin for all the help he has given me over the years.

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CHAPTER 1 – LITERATURE REVIEW

1.1 HISTORY OF EYE BANKING

An eye bank is an organisation whose main function is to acquire suitable corneal tissue and make it available as material for corneal transplantation. Graham[1] reviews the history of eye banking: The first documented human corneal transplant was performed in 1838 by R. S. Kissam. This he performed by transplanting a pig's eye into a human but the attempt failed largely due to corneal rejection.

The first successful attempt at corneal transplantation was performed by E. Zirm of Moravia (Czechoslovakia) in 1905. He used corneal tissue from an 11 year old boy to perform a corneal graft in a chemical-burns patient. Despite the increased risk of graft rejection associated with this type of injury, his graft remained clear for several years following surgery.[1]

Throughout these early years of surgical attempts, no method existed for the storage of corneal tissue. This essentially meant that corneal tissue had to be used as soon as it was harvested.

The earliest documented attempt at eye banking was by A. Magitot in 1911.[1] He is reported to have preserved whole eyes for up to 2 weeks from animals of similar species at temperatures of 5^{o}C to 8^{o}C. He reported successful corneal transplantation using corneal tissue stored in such a medium.

It was only in 1945 that the first modern eye bank was founded by R. Paton.[1] This was the "Eye bank for Sight Restoration" in the state of New York. This was followed by the establishment of several other eye banks in other states of America. The major goals of these eye banks were to:

"Provide a supply of donor material to qualified surgeons, support research in and teaching of surgical techniques, provide ocular tissues for experimental work and stimulate research on the causes of corneal blindness, particularly from corneal disease or injury".[1]

By 1961, ten eye banks in the USA had networked to form the Eye Bank Association of America (EBAA).[2] There are about 90 member eye banks for the EBAA today. These eye banks work together to improve both the quality and quantity of cornea and sclera tissues obtained from donors. These tissues are then made available to ophthalmologists throughout America and elsewhere in the world. Similar networks have been established in other parts of the world, such as the European Eye Banks Association, Eye Banks association of India and the Australian Eye Banks Association.

The first eye bank in South Africa was the Eye Bank Foundation of South Africa in Cape Town and was established in 1975.[3] Since then, four other eye banks were established. These are the Gauteng Cornea and Eye Bank (GCEB) in Johannesburg; the Pretoria Eye Institute Eye Bank in Pretoria; the KwaZulu Natal Cornea and Eye Association in Durban and the Goosen Eye Bank in Port Elizabeth. With a population of about 47 million people (Statistics South Africa) and just more than 300 ophthalmologists (Ophthalmological Society of South Africa), South Africa needs a well coordinated program of eye banking.

The Gauteng Cornea and Eye Bank (GCEB) in Johannesburg, the subject of this research, was established in 1995. It is a non-profit organisation which was established under the joint sponsorship of the Ophthalmological Society of South Africa, the Lions fight-for-sight Foundation and the Clinic Holdings group.[4] Its main responsibility is to collect eyes from suitable donors and

make them available for ophthalmologists' use in both the private and public sectors, mostly in the Johannesburg area of Gauteng.

1.2 EYE BANKING

The main function of an eye bank is to collect donated eye tissues, store them and supply ophthalmic surgeons with these tissues as needed. A successful eye banking program is therefore ultimately judged by its ability to meet and exceed the demand for corneal tissues and supply surgeons with suitable graft tissue.

Functionally, the eye bank has administrative and medical sections. The administrative section typically has a coordinator who oversees the day-to-day running of the bank. This includes regular communication with local hospitals so that potential donors can be identified early. The coordinator also makes use of a team of well-trained technicians available seven days a week to remove globes from suitable donors.

The medical section deals primarily with tissue harvesting and storage. These include such functions as serological testing of donors. The medical section, under the supervision of an ophthalmologist and preferably a corneal specialist, adheres to a strict protocol when identifying suitable tissue for harvesting. The Eye Banks Association of America has a set of guidelines used by its affiliated eye banks. Over and above these functions, the eye bank also helps increase the community awareness about the importance of organ and tissue donation.

Most eye banks are non-profit organisations mostly funded by donations. The day to day running of an eye bank is usually funded by money recovered from corneal recipients and in some cases; subsidy from local governments. GCEB policy decision and human resource matters are handled by the bank's board of directors. Salaries of full-time employees such as the bank's coordinator

and other administrative assistants are decided by the board of directors and the money comes from recipients in the form of paying for donor tissue.

1.3 CORNEAL TRANSPLANTATION AND PREVENTABLE BLINDNESS

It is estimated that of the 37 million people who are blind worldwide, corneal aetiologies could account for up to 10 million. This essentially makes corneal pathology one of the leading causes of blindness worldwide.[5, 6]

Compared to other organ transplant procedures, corneal graft is considered the most successful. This is mainly due to the fact that the cornea is "immune-privileged" and is thus associated with infrequent occurrence of graft rejection. It is therefore well positioned to be an integral part of any program designed to eradicate preventable and treatable blindness.

The Eye Bank Association of America (EBAA) has put the annual number of penetrating keratoplasties done between 1990 and 2000 at more than 30 000. During the same period, the number of corneas exported by EBAA member eye banks rose steadily from 2726 in 1990 to 13 689 in 2000. This indicates a generalized need for corneal material the world-over.[7]

In South Africa, the extent of blindness due to corneal aetiologies is unknown.[3]

1.4 SHORTAGE OF CORNEAL TISSUE

Countries with successful eye banking programs have either no waiting lists or have significantly decreased their waiting lists relative to the population's needs. In the United States of America (USA), any patient who is an appropriate candidate to corneal graft is assured a suitable cornea for transplantation. In the case of an emergency, such as a corneal perforation, tissue is always available.[7] If a patient was to wait for corneal transplant in the America, factors such as the surgeon's personal preference for certain tissue characteristics or the patients' factors which are unrelated to the donor tissue, will be the cause of such delay.[7]

The European Eye Banks Association, which coordinates eye transplant needs of about 23 countries, has a waiting list of about 800 patients.[8] The waiting period in member countries is about 8 months for routine operations and there is no waiting time for emergency cornea transplantation, such as in the case of corneal perforation. The United Kingdom Transplant Service estimates that most corneal transplants in the United Kingdom are carried out on scheduled operating lists with up to two weeks' notice being given to the recipient.[9] There is no waiting list in South Australia and recipients are assured corneal material within one week of such requisites being made to the eye bank.[10]

The success of these countries is attributed to a variety of factors. The most notable of these is the impact of educational campaigns aimed at increasing public awareness about the good that can come out of corneal transplantation. As many as 95% of Americans are aware of the existence of transplantation and about 75% say they will be willing to donate an organ after death.[11] These significant numbers can be attributed to widespread educational campaigns on transplantation activities.

The enactment of some laws is another very important factor in helping enhance the procurement of donor tissue. This has helped increase eye donations by up to 60% in some countries.[12] These laws include those that grant medical examiners the right to approve corneal donation when no family objections were known before death, such as the Justice of the Peace/Medical examiner law. There are also routine inquiring laws which oblige hospital personnel to ask the next of kin if the deceased has expressed a wish to be a donor. The enactment of the transplantation law in Germany has helped increase the number of corneas harvested by 75%.[13] This law makes "opting in" organ donation by the next of kin of potential donors mandatory. This essentially declares all patients as donors until they opt out of the program. It further obliges physicians and administrators to support surgeons planning organ donation, by asking the next of kin of potential donors for organs.

Unlike most developed countries, less developed countries continue to have long waiting lists for corneal transplantation. The organ donor foundation estimates that in South Africa, there was a 27% drop in the number of transplants undertaken in 2004 compared with 2003. Although the foundation gives no reasons for this drop, donor material shortage may be the most important limiting factor.

This inadequate supply of donor corneas can be attributed to factors such as:

a) Lack of Funding

Most eye banks, as non-profit organisations, rely largely on donations and cost-recovery from corneal tissue recipients. It is such funds that help run the day to day activities of the bank. The bank also needs to pay its administrative staff and cornea harvesting technical staff consistently and reasonably. These are the people who help the bank to communicate with potential donor's family members so that donor tissue can be secured. Unavailability of good regular funding can make it very difficult to manage such facilities and ultimately lead to decreased capacity to procure corneas.

b) Lack of Awareness

This refers to the awareness of both the public and healthcare workers. Variations in procurement rates among hospitals are, to some extent, seen as a reflection of the failure of healthcare professionals to request donation from families of the deceased. Pont[14] noted that at their general hospital, only 30% of their potential tissue donors eventually become actual donors. This small percentage was attributed to lack of awareness of donation by healthcare workers and their ultimate failure to notify the transplant coordinator of the potential donor in their hospital. Bredehorn [15] observes that about 60% of patients who died in their hospital from April 1999 to April 2000 had not given consent because healthcare workers had not asked their next of kin for consent. Increased and improved identification of potential organ donors resulted in an almost threefold increase in organ donation in Sweden between 1996 and 1998.[16]
This emphasises the importance of educational programs which target both the community and healthcare workers.

c) Community attitudes and religious background

Socio-cultural and religious beliefs also play a vital role in influencing procurement of donor material.[5] The temple-based eye banking in Nepal has managed to dramatically increase their corneal tissue procurement by more than 160% by simply involving monks and priests in counselling bereaved family members on the decision to donate the corneas of their deceased relative.[5] In their scientific letter to the editor, they noted that observing death rituals and enlisting social and religious leaders to provide culturally specific rationales for tissue donation is also important in establishing eye banks. Diamond et al noted that subpopulations traditionally not donating corneas, such as the Jewish community, are able to donate when requested to do so. Twenty eight percent of Jews who were requested to donate agreed to do so.[17]

In South Africa, Pike[18] noted that high percentages of whites (99%), rural blacks (84%) and urban blacks (76%) are prepared to donate their organs, which to a large extend dispels the myth that black people are generally unwilling to donate organs. This group further noted that the same groups were unwilling to donate the organs of their close relatives; whites (76%) rural blacks (76%) and urban blacks (67%). They mostly felt that this decision should be made by the person before death. This further highlights the importance of good educational programs so that people can consent about their own corneas while still alive and make relatives aware of their decision.

Lack of this education can make people unwilling to donate. Corneal grafting is not well understood in some communities and this could partly explain the unwillingness of such communities to donate. Only 23% of blacks are willing to donate corneas compared to 69% and 70% willing to donate kidneys and hearts respectively.[18] Educational programs may be valuable in increasing awareness about the value of corneal grafting.

1.5 INDICATIONS FOR PENETRATING KERATOPLASTY

The commonest indications for corneal graft in most developed countries are keratoconus and pseudophakic bulbous keratopathy. The prevalence in the United States of America (USA) and Western Europe ranges from 15% to 20% and 21% to 27% respectively.[19] Other developed countries similarly report high occurrences of keratoconus and pseudophakic bullous keratopathy of 46% and 18% respectively in New Zealand and 30% and 25% respectively in Australia.[20, 21] Corneal scarring remains the leading indication in developing countries, ranging from 18% to 52%.[22] Al-Towerki[22] noted that the leading indication in their group has changed from corneal scarring which accounted for 52% between 1983 and 1987 to keratoconus which accounted for 40% between 1998 and 2002 in Saudi Arabia. They attribute this change to the socio-economic development during this period.

This report will also examine the indications for corneal graft in some private practices served by GCEB and compare them with those from elsewhere in the world.

CHAPTER 2- METHODS

2.1 AIM

To analyze the donor and recipient corneal graft patients in Johannesburg and thereby help identify population groups to target in order to increase corneal donation.

2.2 OBJECTIVES

- To describe donor demographics; source, utilisation and distribution of corneal tissue procured by the Gauteng cornea and eye bank (GCEB)
- Establish the indications for corneal grafting in this recipient population of Johannesburg

2.3 STUDY DESIGN

Retrospective case review study, using available records at Gauteng cornea and eye bank (GCEB) and clinical records of selected corneal surgeons in Johannesburg (arbitrarily defined as those having done 15 or more corneal grafts over the period from 01 January 1998 to 31 December 2000).

Data collected included:

- Demographic details- age, sex, race, referral area of the donor cornea and recipient's doctor (whether they work in the public or private sector)
- Indications for corneal graft

2.4 DATA COLLECTION AND STATISTICAL ANALYSIS

Information was recorded on a data collection form and placed onto an Excel computer program worksheet. Statistical analysis was performed in consultation with Prof TR Carmichael.

Descriptive statistics were used to present the general demographic profile of patients such as age, race and sex. In situations where groups needed to be compared, such as the mean age of used and discarded corneas, I used the Student *t* test to compare means between groups.

Linear regression analysis was done to describe demographic trends over the years of the study. Significant trend changes were recorded using the *B*-coefficient and p-values. GraphPad InStat 3 computer program was used for the analysis.

2.5 ETHICAL CONSIDERATIONS

- The study was passed unconditionally by the Ethics Committee of the University of the Witwatersrand on the 04th October 2002. Ethics no: 020909.

CHAPTER 3- RESULTS

3.1 TOTAL

There were 1252 donors from the year 1998 to 2005. The average number of donors per year was 157 (SD 20.01). The highest number of donors was recorded in the year 2002 (n=184), and the lowest in 2000 (n=130), figure 3.1.

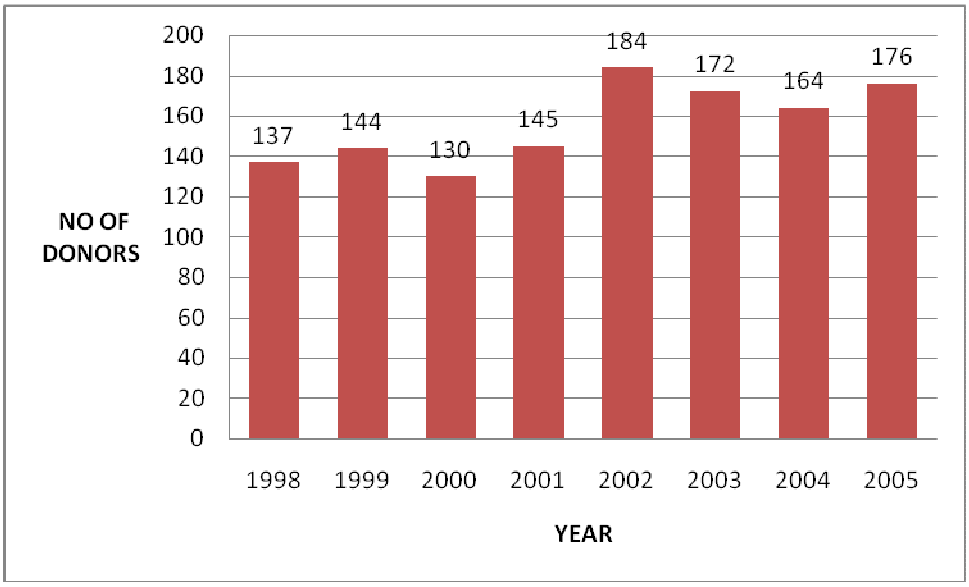


Figure 3.1 The number of donors for each year of study.

There was a statistically significant increase in the number of donors over the study period (B-coefficient = 6.40, standard error=2, 07, p-value=0.02), figure 3.2

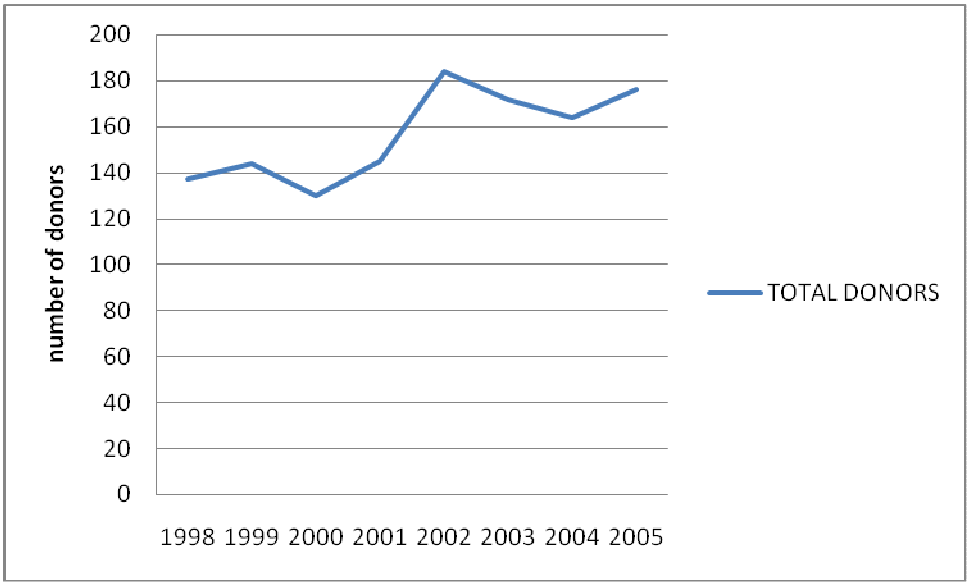


Figure 3.2: Linear trendline showing the number of donors for each year of study (B=6.40, se=2.07, p=0.02)

3.2 GENDER

The majority of donors were males, making up 68.6% (n=859) of the total number of donors compared to females who made up the remaining 31.4% (n=393), figure 3.3. The male to female ratio was about 2:1.

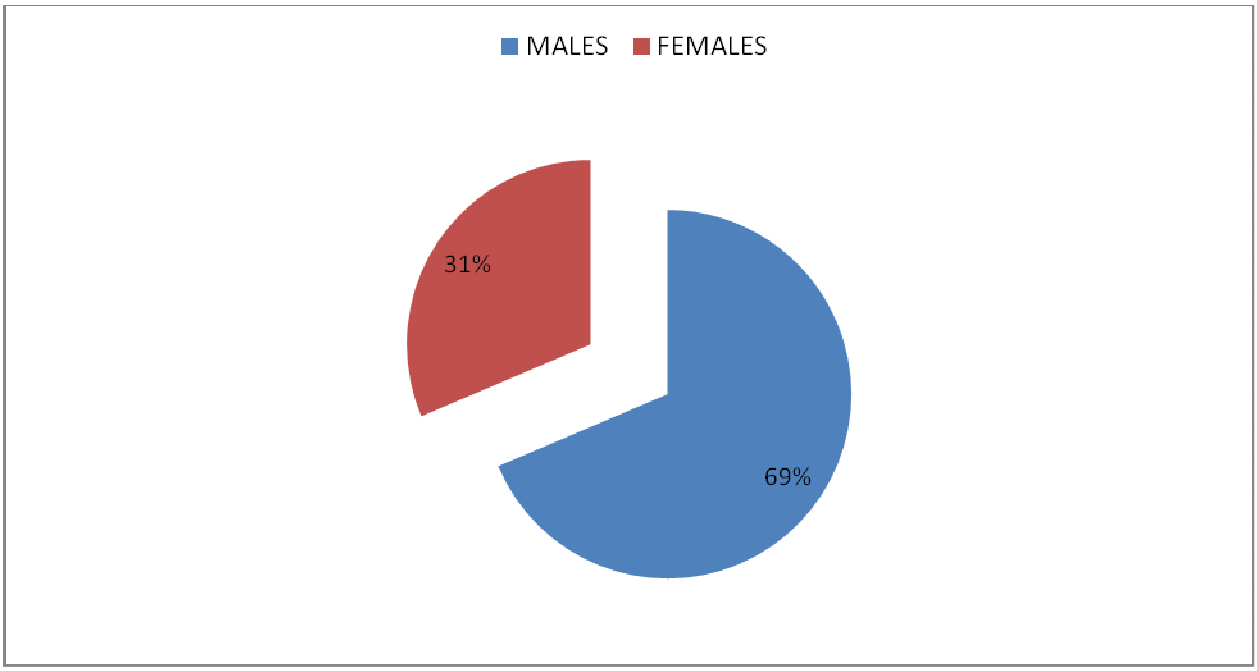


Figure 3.3: A pie chart showing the gender distribution.

The gender distribution showed a male preponderance in every year of study, with an average donor rate of 107 donors per year compared to 49 female donors per year.

Although the male-gender trend tended to increase over the study period (B=6.18, se=2.20, P=0.03), the female gender remained unchanged, showing no significant trends over the study period (B=0.23, se=1.03, p=0.83), figure 3.4.

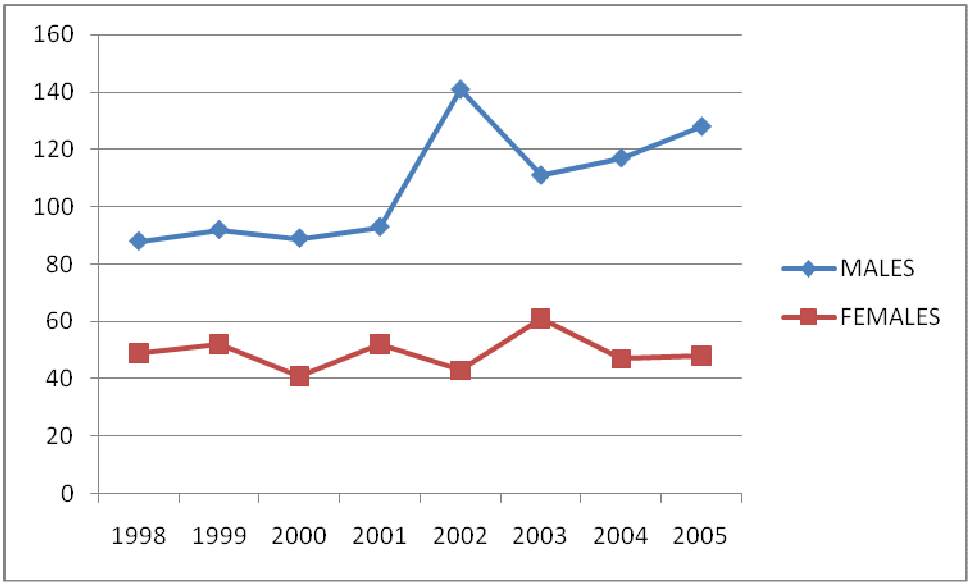


Figure 3.4: A trendline graph showing the gender distribution over the years of study.

3.3 RACE

Whites were an overwhelming majority compared to other races, accounting for 96% (n=1205), followed by Blacks 2% (n=24), Asians 1% (n=18) and Coloureds <1% (n=5), figure 3.5.

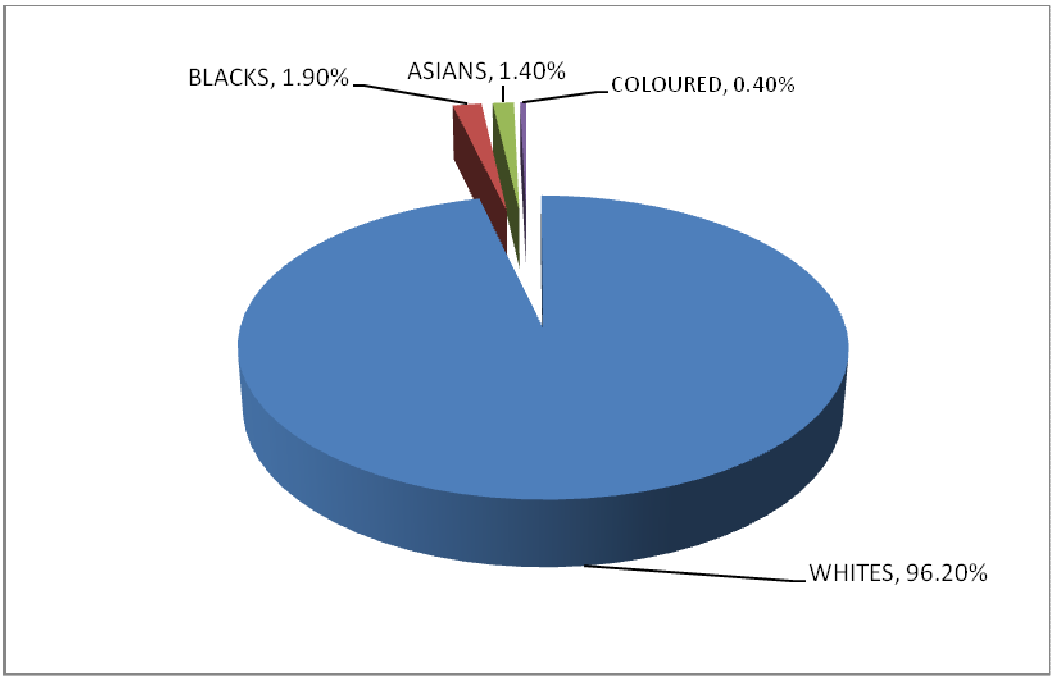


Figure 3.5: A pie chart showing the race distribution.

The preponderance of Whites was maintained throughout the study period. While the other ethnic groups' donation trend remained the same throughout the study period, Whites' donation trend showed a statistically significant steady increase over the same period (B=7.20, se=1.89, p=0.009), figure 3.6.

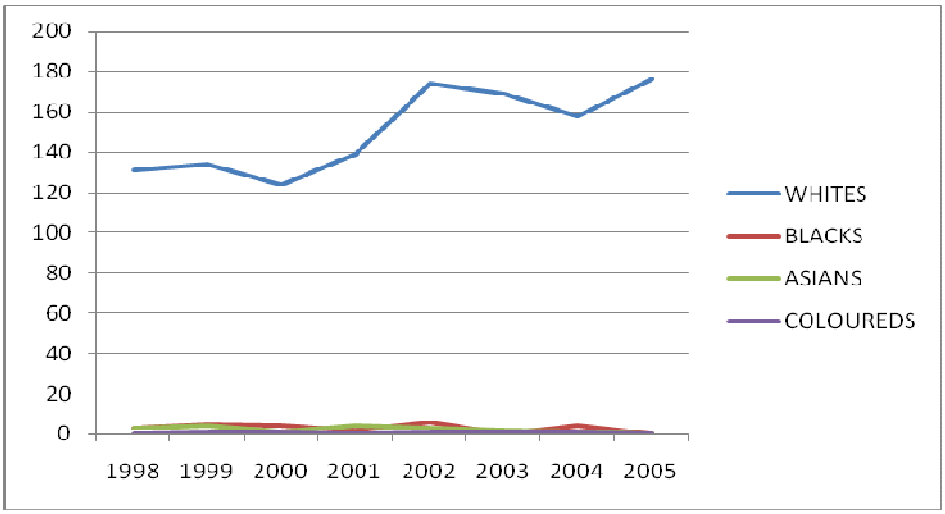


Figure 3.6: A trendline graph showing the race distribution over time.

3.4 AGE

Of the 1252 donors, 1242 (99.2%) had their age recorded. The mean age of donors was 40.4years (Standard deviation=15.97). The youngest donor was three months of age and the oldest was 78 years of age. There were very few donors younger than 10 years of age (2.3%, n=30) and of these, three donors were younger than 1 year of age. Donors who were older than 65 years of age made up 3.4% (n=42) of donors. There was no statistically significant trend of the mean age of donors over the study period, (B=1.65, se=0.33, p=0.999), figure3.7.

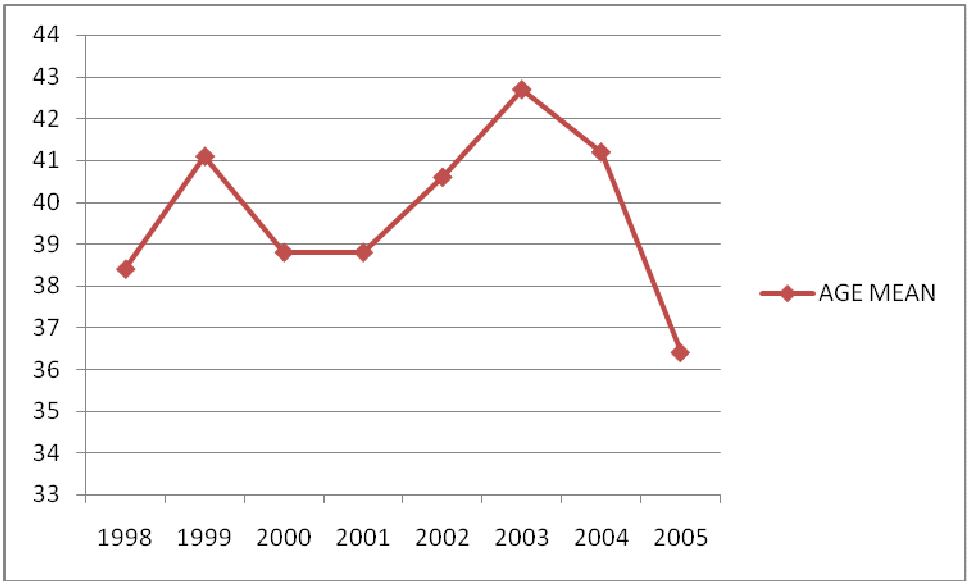


Figure 3.7: A trendline graph showing the mean age of donors over the study period.

3.5 SUITABLE TISSUE

Of the 2504 corneas donated, 87.5% (n=2191) were considered suitable for use in recipients and 12.5 % (n=313) were considered unsuitable and therefore discarded, figure 3.8.

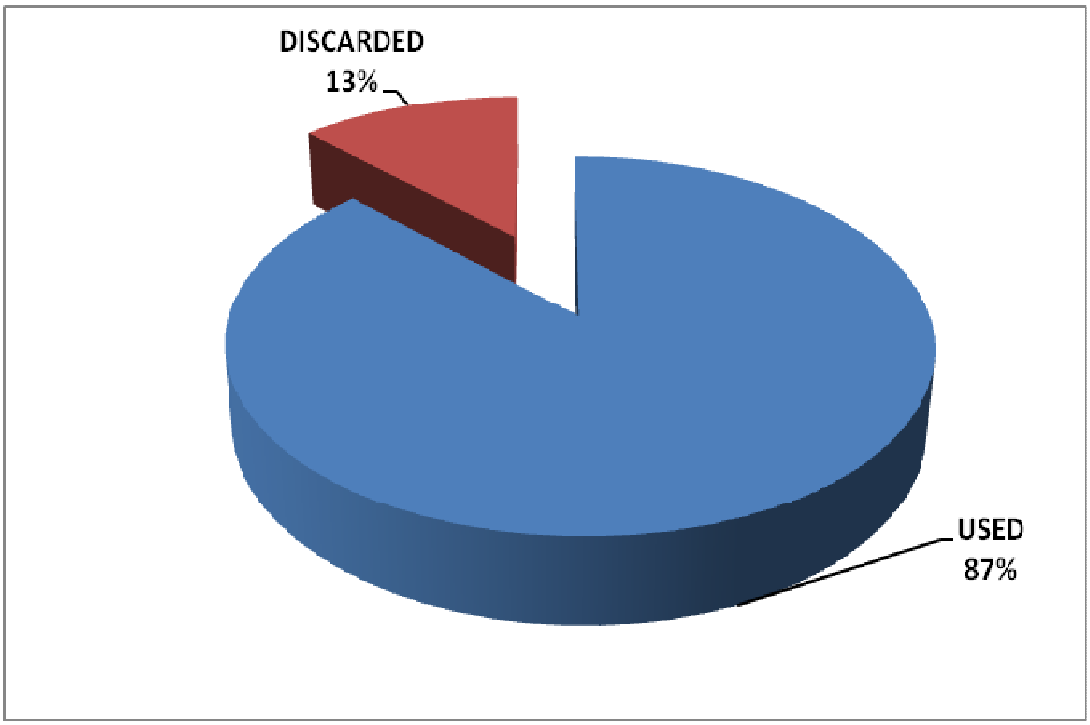


Figure 3.8: A pie chart showing the used and discarded corneas.

The mean age of used corneas was 39.8 years (SD 16.01). Corneas from donors younger than 10 years of age were 53 (2.4%) and from donors older than 60 years were 274 (12.5%). Of these, seven corneas were from donors older than 70 years of age. Seventeen records did not have age of donors recorded. The corneal utilization rate, the proportion of donor corneas used,

significantly decreased over the study period (B= -1.76, se= 0.48, p=0.01). There was a corresponding increase in the proportion of donated corneas which were discarded over the years of study, figure 3.9.

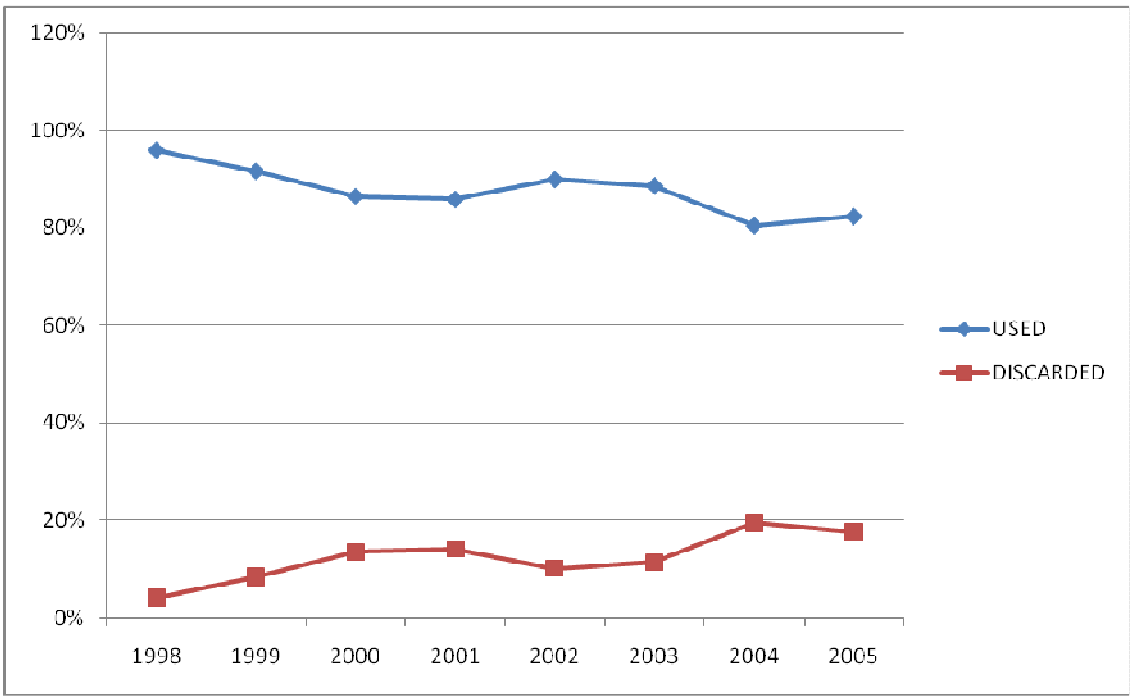


Figure 3.9: A trendline graph of used and discarded corneas over the study period.

The youngest discarded cornea was six months of age and the reason for discarding it was the unavailability of suitable recipients. The commonest reason for discarding corneas was damaged corneas, accounting for 36% of all unsuitable corneas. Causes of this corneal damage ranged from traumatic injury to scarring from previous keratitis. Human immunodeficiency virus contamination was the second commonest reason for discarding corneas, accounting for 18% of discarded corneas. Other reasons include: inconclusive blood results on serological testing (14%) and positive hepatitis serology (8%) on blood testing.

Twenty-five percent discarded corneas had no reasons recorded, table 3.1.

Reason for discarding	**Percentage of discarded corneas**
Damaged corneas	36%
HIV	18%
Inconclusive blood results	14%
hepatitis serology	8%
Not recorded	25%

Table 3.1. A table showing reasons for discarding corneas.

There was a difference in the mean age of used corneas, 39.8 years, compared to that of discarded corneas, 44.9 years and this difference was highly statistically significant ($p<0.0001$).

3.6 HOSPITAL WHERE CORNEAS WERE USED

Most of the donor corneas were used in private hospital recipients, accounting for 91% compared to only 9% used in public hospitals, figure 3.10.

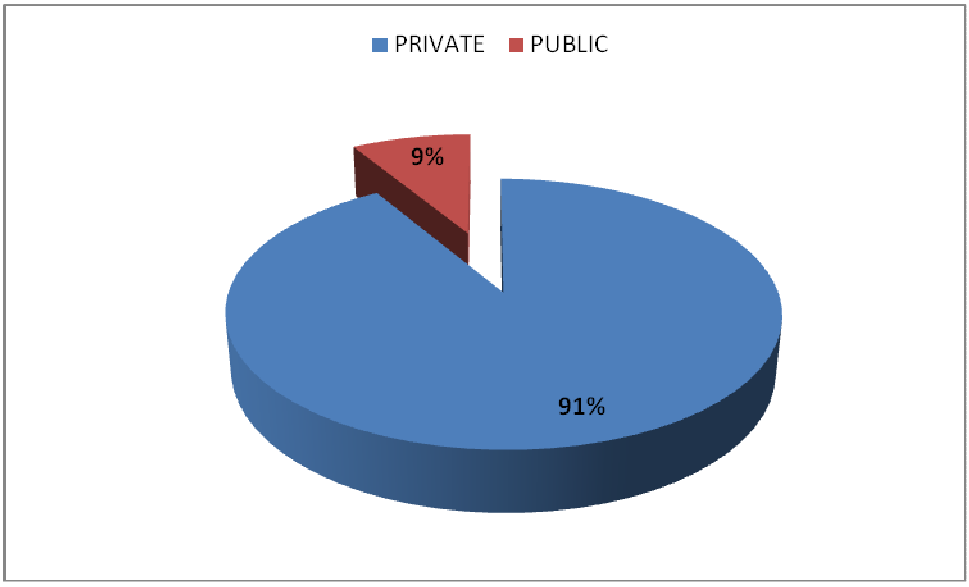


Figure 3.10: A pie chart showing the distribution of hospitals where corneas were used.

There was a slight increase in the distribution of corneas to private hospitals and a decrease to public hospitals over the study period, but this was not statistically significant (B=1.12, se=0.49, p=0.06), figure 3.11.

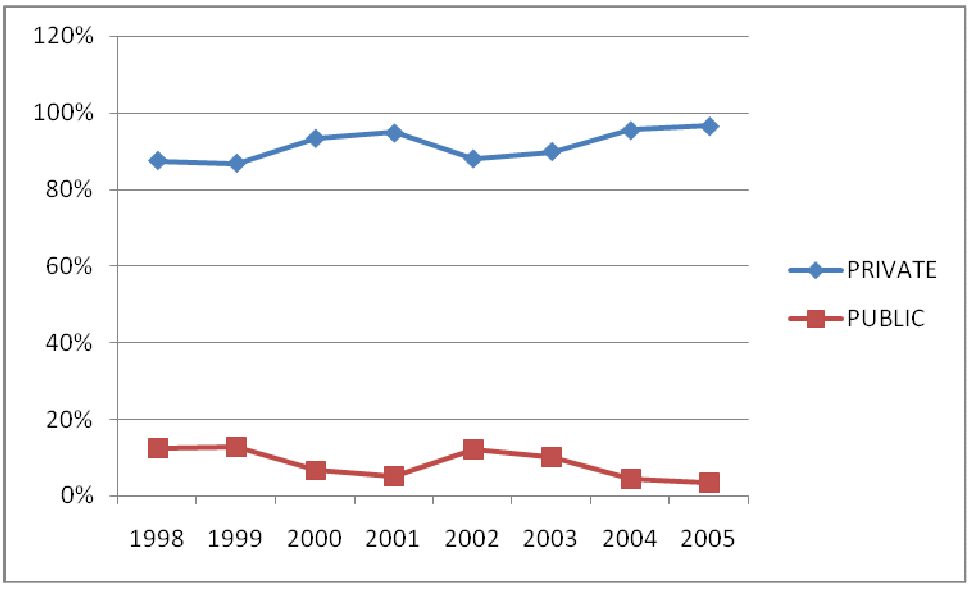


Figure 3.11: A trendline graph showing the distribution of hospitals where corneas were used over the study period.

3.7 REFERRAL

The greatest number of referrals came from mortuaries (50%, n= 612) followed by private hospitals (37%, n= 456). Public hospitals contributed only (11%, n= 136) of all the referrals, table 3.2.

Referral source	**Number of corneas referred**	**Percentage**
Mortuary	612	50%
Private hospitals	456	37%
Public hospital	136	11%
Other	48	2%

Table 3.2 A table showing corneal tissue origin.

Referrals from mortuaries showed a significant increase from the year 2001 through to 2005. Public hospitals did not increase their referrals during this period and in fact showed a slight decrease, figure 3.12.

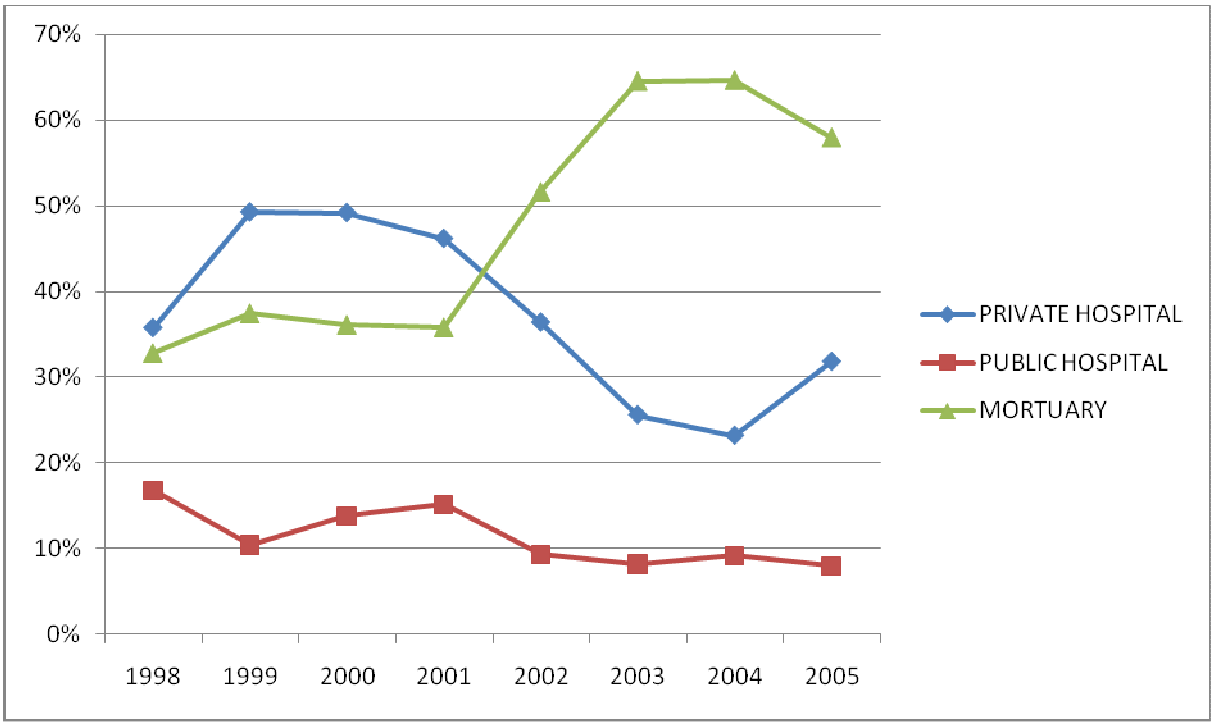


Figure 3.12: A trendline showing the distribution of referrals over the study period.

There were no reasons given for the sharp increase in referrals from mortuaries and a corresponding decrease in private hospitals' referrals in the year 2001.

3.8 CORNEAL GRAFT INDICATIONS

A total of five ophthalmologists met the criteria for high volume corneal graft surgery in Johannesburg (>15 grafts in the period 1998 to 2000). One had already left Johannesburg at time of commencing the study. One surgeon could not make their records available. As a result I ended up analysing records from only three out of the five originally selected surgeons.

Data used for analysis of indications of penetrating keratoplasty were collected during the initial phase of the study (the first three years). This is largely due to the fact that some of the surgeons who were originally part of the study relocated and therefore data collected during the second phase were going to make the results difficult to interpret.

A total of 79 penetrating keratoplasties were done. The commonest indication was keratoconus: n=37 (46.8%), followed by corneal scarring: n=22 (27.8%) and pseudophakic bullous keratopathy: n=8 (10.1%), table 3.3.

INDICATION	**NUMBER**	**PERCENTAGE**
KERATOCONUS	37	46.9%
SCARRING	22	27.8%
PSEUDOPHAKIC BULLOUS KERATOPATHY	8	10.1%
KERATITIS	3	3.8%
TRAUMATIC CORNEAL PERFORATION.	2	2.5%
0THER	7	8.9%

Table 3.3 A table showing the indications for corneal graft.

Active keratitis and traumatic perforation, both considered to be surgical emergencies, were indicated in only five cases (6.3%).

Most of the corneal scarring cases were due to trauma (45.5%) and Lasik (18.2%), figure3.13.

SCARRING	NUMBER	PERCENTAGE
TRAUMATIC	10	45.4%
LASIK	4	18.2%
KERATITIS	4	18.2%
UNSPECIFIED	4	18.2%

Table3.4 A table showing causes of corneal scarring.

CHAPTER 4- DISCUSSION

There was a statistically significant increase in the total number of donated corneas from 1998 to 2005. The question of whether such an increase was sufficient is difficult to answer; this is largely because the demand for corneal tissue in Gauteng is not known. To know this, one would need accurate statistics on patients awaiting corneas in this province and such statistics are not kept. What is known, from unpublished data in tertiary public hospitals of Johannesburg, is that non-emergency corneal graft patients can wait for up to a year to get donor tissue. This would perhaps mean that this steady increase has not been sufficient.

With a population of just over 10 million,[23] the Gauteng province has a population size that is more than double that of New Zealand and yet has corneal donor rates far less. In their study, Patel[24] point out that corneal donor rate of 29.2 per million population has enabled all corneal transplants in New Zealand to be electively done within 2 to 4 months of patient presentation. The Johannesburg region of the Gauteng province, in comparison, has a corneal donor rate of 18.5 per million population and an average waiting time much longer than that of New Zealand. After reviewing numerous published papers on the value of corneal transplantation in reducing blindness, Garg [25] note that the developing world carries most of the load of corneal blindness. This would mean that countries such as South Africa will need to achieve corneal donation rates far in excess of 29.2 per million population achieved in countries such as New Zealand, to sufficiently deal with reversible corneal blindness.

The gender distribution showed that males were in the majority in every year of study. On average, there were 859 (69%) males compared to 393 (31%) females. This male preponderance is similar to that found in other studies elsewhere in the world. Patel[24] attributes this to the fact

that men generally die at a younger age than women. In South Africa, the death rate pattern is similarly dominated by males. Data from Statistics South Africa indicate that the death rate per 100 000 is dominated by males for every age group older than 30 years.[26]

Whites have consistently donated more than 90% of all corneas since the inception of the eye bank. This is despite the fact that they are not the majority race in the Gauteng province, making up only 19.9% of the province's population.[27] The majority race group in the province is Black, comprising 73.8% of the population. Blacks, however, only managed to contribute 1.9% of the total corneas donated over the study period.

Throughout the study period, the contributions of both Whites and Blacks have remained constant, with the exception of 2005 when Whites donated 100% of the corneas.

The demand for corneal tissue will probably never be met in this country if the majority race group in the country is not participating sufficiently in the donation programs.

This highlights the importance of intensifying procurement programs in traditionally Black communities. Tandon [28] demonstrated that factors such as literacy and socio-economic status do not have any influence on willingness to donate corneas. It is therefore important to keep on targeting communities with low donation record because every family has a potential donor and, with good counselling, can agree to donate corneas.

The mean age of donors was 40 years. This is younger than the 60 years reported by Patel.[24] With a life expectancy of 50 years for males and 53 years for females, this young mean age of donors is to be expected in South Africa.[29]

The corneal utilization rate (the proportion of donor corneas used for transplantation) was 87% for young corneas (59 years and younger) and 77% for old corneas (60 years and older). Although there was a difference in the corneal utilization rate between these age groups, many of the corneas from the older donors were used suggesting that donor age alone does not indicate poor quality corneal tissue.

This high utilization rate for old donor corneas is similar to that reported by Patel[24] but much higher than the 45-53% reported elsewhere.[30, 31] The suitability of older corneas for transplantation remains controversial. The theoretical disadvantage of using older corneas is based on the fact that increasing donor age is associated with a decrease in the endothelial density. Gain[31] found no difference in the graft survival, visual acuity and endothelial density between young (under 50 years) and old (over 70 years) corneas. More recently, the Cornea Donor Study Investigator Group[32] found that the five year graft survivals are similar for donors aged 66 years and younger compared to donors who are 66 years and older. The important factor appears to be the pre-operative endothelial cell density irrespective of the age of the donor. The Eye Bank Association of America (EBAA) has not proposed the upper limit of the age of donor and has left the decision to the discretion of individual member eye banks.

The youngest donors were three months of age and both of their corneas were suitable for transplantation. The EBAA proposed the lower limit of donor age to be full-term birth but most eye banks will only accept donor corneas of infants older than three months. This is because problems associated with young corneas, such as a myopic shift, occur predominantly with corneas from infants younger than three months. [33, 34]

A worrying trend noted during the study is that the proportion of donated corneas which were ultimately used in penetrating keratoplasty showed a statistically significant decline over the study period (B-coefficient= -1.76, standard error=0.48, p-value=0.01), with a resultant increase in discarded corneas. The reasons for this trend are not apparent from the available data. This could be due to the fact that either the eye bank has become rigorous in screening for unsuitable corneas or that conditions rendering corneas unsuitable, such as human immunodeficiency virus infection, have become more prevalent. Further studies will be needed to specifically answer this question.

The commonest reason for discarding corneas was damaged corneal tissue, accounting for 36% of all discarded corneas. The cause of this damage was not specified. It is therefore difficult to suggest how this problem can be avoided in future. If such corneal damage was as a result of harvesting, then better training of personnel will help to reduce this figure to more acceptable levels. Other studies do not report such high levels of damaged corneas in their discarded corneas.[24]

Human immunodeficiency virus (HIV) infection was the second most common reason for discarding corneas, accounting for 18% of all discarded corneas. In a country with an estimated 5, 35 million people infected with human immunodeficiency virus,[23] this high prevalence of infection amongst the donor population is not surprising and could turn out to be the most important impediment to increasing the pool of suitable donors. Unfortunately the proportion of discarded corneas without a recorded reason for discarding was very high at 25%.
Most of the corneas were used in the private hospitals, 91% versus 9% used in the public hospitals. This trend was maintained throughout the study period. This is in contrast to results from elsewhere in the world where the majority of donated corneas are distributed to the public

hospitals.[24] Patel reported a ratio of 2:1 public to private distribution. This disparate distribution between public and private sectors in Johannesburg is made worse by the fact that the public sector treats about 80% of the total population of South Africa but only 9% of all donated corneas are distributed to this sector.[35]

Reasons for this disparity are not given but funding limitations in the public sector may be one of them. The prospect of eradicating treatable corneal blindness will, to a very large extent, also depend on the existence of some cooperation between the private and public sectors.

The greatest number of referrals (50%) came from the mortuaries. This was followed by the private hospitals' contribution of 37% of all the referrals. There has been an informal agreement between mortuaries in Johannesburg and the eye bank which promoted the referral of all deaths handled by some mortuaries and this has managed to keep the cases referred to the eye bank consistently high.

Some private hospitals, specifically the Netcare group of hospitals, have made it mandatory for their clinical staff members to refer all patients who die in their hospitals to transplant coordinators for an assessment. This strategy has helped increase the pool of available donor corneas over the years. The public hospitals, catering for about 80% of the general population, should probably be the biggest contributor to the referral pool. It is therefore disappointing that these hospitals contributed only 11% of the total referrals. This is probably due to the fact that almost all public hospitals have no policy on referring suitable potential donors to the eye bank coordinator.

Keratoconus was the commonest indication for penetrating keratoplasty, accounting for 46.8% all corneal grafts done during the period of the small survey of private ophthalmologists. Claesson[36] reported a similar trend in their analysis of corneal grafts done at the St John Eye Hospital (Jerusalem) and Sweden. They found that keratoconus was the commonest indication in both the Jerusalem and Sweden hospitals, accounting for 51% and 27% of grafts in these hospitals respectively. Other developed countries have also reported a similarly high occurrence of keratoconus as the commonest indication.[20] This similarity is not unexpected, given that private clinical practices in South Africa provide for the most affluent communities. Pseudophakic bullous keratopathy was not as common as it has been reported in other studies. It only accounted for 10.1% of all indications. It has been reported to be as high as 24.8% and 40.9% in Canada and America respectively.

Trauma was the commonest cause (45.5%) of corneal scarring in this group of patients. Lasik accounted for 18.2% of scarring. This high contribution of Lasik to corneal scarring is in keeping with the widespread use of Lasik as a management tool in refractive surgery. Of interest is the fact that active keratitis and traumatic corneal injury, both considered to be emergency cases, only accounted for 6.3% of all the cases.

CHAPTER 5-CONCLUSIONS

The results of this report of the Gauteng cornea and eye bank show that corneal donation from the black population in Johannesburg is suboptimal. There has been a statistically significant steady increase in the number of donors annually over the period: 1998 to 2005. There was a great disparity between the number of corneas distributed to the public and private hospitals, with the private sector having received the vast majority of donor corneas.

Corneas from older subjects may be as useful as those from young subjects. The high prevalence of human immunodeficiency virus infection in South Africa will continue to render a significant number of donated corneas unsuitable for use in penetrating keratoplasty.

In private ophthalmology practices in Johannesburg, keratoconus remains the commonest indication for penetrating keratoplasty.

CHAPTER 6- RECOMMENDATIONS FOR FUTURE WORK

1. It became apparent during the course of this study that records kept by the Gauteng cornea and eye bank on regional corneal graft activities could be expanded to include corneal graft indications from clinicians.
2. Better coordination of corneal graft activities will be achieved if all eye banks in South Africa operate under an umbrella body similar to the Eye Bank Association of America. This will help standardise such activities as the storage and distribution of corneal tissues and encourage the sharing of information on corneal grafts.
3. Better involvement of the government in terms of improved funding will help reduce eye banking costs and ultimately decrease the public hospitals' costs of acquiring corneas.
4. Government's enactment of appropriate legislation may help improve corneal donation in communities that do not donate corneas.
5. Involvement of community leaders in promoting corneal donation in communities that do not donate corneas may help alleviate cornea tissue shortage.

CHAPTER 7- REFERENCES

1. Graham Jr CR. Eye banking: a growth story. Transplant Proc 1985;17:105-111.
2. Farge EJ. Eye banking: 1944 to the present. Surv Ophthalmol 1989;33:260-263.
3. Murray ADN. Penetrating keratoplasty and eye banking in South Africa. Refract Corneal Surg 1991;7:456.
4. Kuming BS. Gauteng Eye Bank. S Afr Med J 1996;86:93.
5. Ruit S, Tabin G, Gurung R, Shattuck T, Murchison A, Dimmig J. Temple Eye Banking in Nepal. Cornea 2002;21:433-434
6. Dandona L,Dandona R. What is the global burden of visual impairment? In: BMC Med 2006;4:6 doi:10.1186/741-7015-4-6.
7. Aiken-O'Neill P, Mannis MJ. Summary of Corneal Transplant Activity: Eye Bank Association of America. Cornea 2002;21:1-3
8. Kalter ESJ, de by TMMH. Tissue banking programmes in Europe. Br Med Bull 1997;53:798-816.
9. Ridgway AE, Marcyniuk B. The UK cornea transplant service and the establishment of the David Lucas Manchester eye bank. Dev Ophthalmol 1991;22:44-49.
10. Philpott M, Bain M, Coster DJ. Procurement of all the donor corneas needed: how is it achieved? Transplant Proc 2000;32:69-71.
11. Siminoff LA, Arnold RM, Caplan AL, Virnig BA, Seltzer DL. Public Policy Governing Organ and Tissue Procurement in the United States. Results from the National Organ and Tissue Procurement Study. Ann Intern Med 1995;123:10-17.
12. Farge EJ, Silverman LM, Khan MM, Wilhelmus KR. The impact of state legislation on eye banking. Arch Ophthalmol 1994;112:180-185.
13. Reinhard T, Böhringer D, Bogen A, Sundmacher R. The transplantation law: a chance

to overcome the shortage of corneal grafts in Germany?Transplant Proc 2002; 34: 1322-1324.

14. Pont T, Gràcia RM, Valdés C, et al. Theoretic rates of potential tissue donation in a university hospital. Transplant Proc2003;35:1640-1641.

15. Bredehorn T, Eichhorst A, Langer C. The importance of reporting corneal donors. Transplant Proc 2002;34:2339.

16. Norberg U, Söderlind K, Franzén L, et al. A modified “spanish model” for organ donation in the southeast region of sweden. Transplant Proc 2000;32:72-74.

17. Diamond GA, Campion M, Mussoline JF, D'Amico RA. Obtaining consent for eye donation. Am J Ophthalmol 1987;103:198-203.

18. Pike RE, Odell JA, Kahn D. Public attitudes to organ donation in South Africa. S Afr Med J 1993;83:91-94.

19. Cosar CB, Sridhar MS, Cohen EJ, et al. Indications for Penetrating Keratoplasty and Associated Procedures, 1996-2000. Cornea 2002;21:148-151.

20. Edwards M, Clover GM, Brookes N, et al. Indications for Corneal Transplantation in New Zealand: 1991-1999. Cornea 2002;21:152-155.

21. Williams KA, Muehlberg SM, Lewis RF, Coster DJ. How successful is corneal transplantation? A report from the Australian Corneal Graft Register. Eye 1995;9:219-227.

22. Al-Towerki AE, El-Sayed Gonnah C, Al-Rajhi A, Wagoner MD. Changing Indications for Corneal Transplantation at the King Khaled Eye Specialist Hospital (1983-2002). Cornea 2004;23:584-588.

23. Mid-year population estimates 2008. (Accessed at <http://www.statssa.gov.za/publications/P0302/P03022008.pdf>)

24. Patel HY, Brookes NH, Moffatt L, et al. The New Zealand National Eye Bank Study 1991-2003: A Review of the Source and Management of Corneal Tissue. Cornea 2005;24:576-582.

25. Garg P, Krishna PV, Stratis AK, Gopinathan U. The value of corneal transplantation in reducing blindness. Eye 2005;19:1106-1114.

26. Advance release of recorded deaths. 1997-2000. (Accessed at http://www.statssa.gov.za/publications/P03091/P030912000.pdf.)

27. Census in brief. (Accessed at http://www.statssa.gov.za/census01/html/CInBrief/CIB2001.pdf)

28. Tandon R, Verman K, Vanathi M, Pandey RM, Vajpayee RB. Factors Affecting Eye Donation From Postmortem Cases in a Tertiary Care Hospital. Cornea 2004;23: 597-601.

29. Global health indicators. (Accessed at <http://www.who.int/whosis/whostat/EN_WHS08_Table1_Mort.pdf>)

30. Armitage WJ, Easty DL. Factors influencing the suitability of organ-cultured corneas for transplantation. Invest Ophthalmol Vis Sci 1997;38:16-24.

31. Gain P, Thuret G, Chiquet C, et al. Cornea procurement from very old donors: post organ culture cornea outcome and recipient graft outcome. Br J Ophthalmol 2002;86:404-411.

32. Cornea Donor Study Investigator Group: Dontchev M, Beck RW, Mannis MJ, Holland EJ, Kollman C, Dunn SP, Heck EL, Lass JH, Montoya MM, Schultze RL, Stulting RD, Sugar A, Sugar J, Tennant B, Verdier DD. The Effect of Donor Age on Corneal Transplantation Outcome: Results of the Cornea Donor Study. Ophthalmology 2008;115:620-626.

33. Palay D, Kangas T, Stulting R, Winchester K, Litoff D, Krachmer J. The effects of donor age on the outcome of penetrating keratoplasty in adults. Ophthalmology 1997;104:1576-1579.

34. Pfister R, Breaud S. Aphakic refractive penetrating keratoplasty using newborn donor corneas. A preliminary report on an alternative approach to refractive correction. Ophthalmology 1983;90:1207.

35. Health care in South Africa. 2008. (Accessed at http://www.southafrica.info/about/health/health.htm.)

36. Claesson M, Armitage WJ. Corneal grafts at St John Eye Hospital, Jerusalem, January 2001-November 2002. Br J Ophthalmol 2004;88:858-860.