AUDIT OF CATARACT SURGERY AT GROOTE SCHUUR HOSPITAL

By Dr. M.I.Motala
Student number : MTLMAH004
Date of Submission : 30 January 2009
Supervisors : Professor Colin Cook and Dr Landon Meyer
Division : Ophthalmology
Department of Surgery
Faculty of Health Sciences
University of Cape Town

SUBMITTED TO THE UNIVERSITY OF CAPE TOWN
In fulfilment of the requirements for the degree

MMed(Ophthalmology)

DECLARATION PAGE

I,Mahommed Ismail Motala,hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Signed by candidate

Signature: .....signature removed

Date: 16 JUNE 2009

ACKNOWLEDGEMENTS

The following people provided help without which this project could not have occurred.

- Prof C.Cook for helping with the design ,funding and overall set-up of the study

- Dr Landon Meyer for endless advice ,insight and encouragement.

- Mrs F.Cassim for data entry within tight deadlines.

-My family including my brother,sisters,mom,dad and wife.

Funding was generously provided by the Ophthalmology Department's surgical research fund

ABSTRACT

(A)OBJECTIVES
To report on the visual outcomes and complications of cataract surgery done at a South African training hospital.

(B)DESIGN AND METHOD:

Literature review and retrospective observational study of all patients undergoing cataract surgery on the cataract surgery project lists during 2006.
Follow-up occurred till last discharge visit.

(C)RESULTS:

1) Primary outcome: Uncorrected visual acuity at the last visit of

6/6 - 6/18 visual acuity was achieved in 73.56% of the phacoemulsification group and in 65.77% of the scleral tunnel extracapsular cataract extraction group. (p=0.103)

2) Secondary outcomes:

Intraoperative complications were noted in 7.34% in the phacoemulsification group and in 12.87% of the scleral tunnel extracapsular cataract extraction group. (p=0.031)

The posterior capsule rupture rate was 3.94% in the phacoemulsification group and 7.6% in the scleral tunnel extracapsular cataract extraction group.(p=0.066)

Best Corrected visual acuity at last visit. In the phacoemulsification group 95.4% of eyes were in the 6/6 to 6/18 visual acuity range and 97.62% of the scleral tunnel extracapsular cataract extraction group were within this range. (p=1.0)

(D)CONCLUSION

The visual outcomes and intraoperative complications of adult cataract surgery at Groote Schuur hospital are within an acceptable range when compared to other studies.

CONTENTS

(1)GLOSSARY

1. Cataract surgical coverage refers to 'the proportion who had cataract requiring surgery (operable cataract) who had had surgery.'[1]
2. ECCE Extracapsular cataract extraction
3. ICCE Intracapsular cataract extraction
4. IOL Intraocular lens
5. MSICS Manual small incision cataract surgery
6. PCO Posterior capsule opacification
7. PHACO Phacoemuslification cataract surgery
8. RD Retinal detachment

(2)PREFACE

This dissertation aims to address the question " What are the visual outcomes and complications of modern cataract surgery for age-related cataract in a South African teaching hospital?"

In the first section I will discuss and introduce the subject and the relevant literature review both in South Africa and elsewhere, and thereafter in the second section I will present the findings of a retrospective study which was conducted in the ophthalmology department at Groote Schuur Hospital,Cape Town,South Africa.

A cataract is the opacification of the crystalline lens within the eye. Senile cataracts occur due to an increase in density of the lens nucleus.This occurs as new lens fibres are added and the lens nucleus becomes compressed.This is manifested as a gradual opacification of the lens ,with gradual deterioration of vision.

The term cataract was introduced by Constantinus Africanus (AD 1010-1087) and it was based on the Latin word cataracta,meaning a "waterfall" or "blockage of flow."

Cataract surgery has evolved from couching to intracapsular surgery and ultimately to extracapsular techniques. [2-5]

(3)CATARACT SURGERY IN TRAINING HOSPITALS IN THE MODERN ERA

(A)INTRODUCTION

Cataracts account for approximately 50% of blindness worldwide and still remain the leading cause of visual impairment in all areas globally.[6;7] Approximately 18 million people are blind from cataract (<3/60 in the better eye) and tens of millions more have cataract low vision.[6] The surgical treatment of cataracts is one of the most cost effective health care interventions.[8] This global tragedy requires the efficient utilization of resources to ease peoples' suffering. The International Agency for the Prevention of Blindness and the World Health Organization seeks to reduce the burden of blindness by the year 2020 through a global partnership called Vision 2020.[7]

In order to allow better data comparison and collection of data the World Health Organisation has created categories of visual impairment. The World Health Organisation uses a visual acuity of less than 3/60 as its definition of blindness.[9] If this level of blindness is achieved in both eyes , the patient is regarded as being socially blind since they have difficulty with normal daily activities.Economic blindness is regarded as having a visual acuity in the better eye of less than 6/60.

Table 1a World Health Organisation Categories of visual impairment

Visual Acuity	**Category – taking into account visual acuity in better eye.**
6/6 –6/18	Normal
<6/18-6/60	Visual impairment/Borderline
<6/60-3/60	Economic Blindness/Severe visual impairment
<3/60-NPL	Social blindness

Tied to the World Health Organisation categories[9;10] , Foster[11] has recommended parameters for assessing quality of outcomes of cataract surgery (appendix 1).Foster recommended that greater than 90% of patients should have a best corrected visual acuity in the 6/6 to 6/18 category , and 80% of patients should be in this category with available correction. Less than 5% of patients should be in the less than 6/60 category either with best available correction or available correction. These figures should be borne in mind , in the evaluation of studies.

Studies have been performed in South Africa looking at the prevalence of blindness and its causes . Cataract blindness is estimated to affect 0.4% of the population in South Africa .[1]

In the year 2000 Davis[12] noted that an estimated 160000 South Africans were blind due to cataract . At that time he also noted that the cataract surgery rate in the public sector was 850 surgical interventions per million population per year (approximately 25000 operations). He estimated that the minimum level to deal with both the backlog and new cases should be in the region of 3000 procedures per million population per annum. In 2000 this equated to the need for 90000 cataract operations per year in South Africa. In a recent study by Cook et al[1] in the North West Province of South Africa , a survey of pensioners showed that 15.6% of pensioners were blind due to cataract(Visual acuity less that 3/60) .The authors noted that that 17.2% of patients had visual acuities in the cataractous eyes of snellen less than 6/60.Among the pensioners 5.6% were noted to have had previous cataract surgery. The cataract surgical coverage using the later standard (of visual acuity less than 6/60) was 24.6%, which is regarded as being low. Ideally this should be 100%.Both Cook et al and Rotchford et al have commented on the reasons for poor uptake of cataract surgery in their respective studies.Cook el al[1] identified that 50.5% of people who were cataract blind did not use the cataract surgery service due to a lack of awareness of a cure for their visual impairment.Rotchford et al[13] researched the reasons for poor cataract surgery uptake in a study in a rural area of South Africa.Fear of surgery was an important reason for the lack of uptake in 45% of subjects,40% of subjects felt that the condition was untreatable and surprisingly 30% of subjects felt that there was no need.In summary , South Africa has a significant population who are blind from cataract.Notwithstanding the improvement in the availability of treatment ,

significant inroads need to be made with regard to patient education and acceptance of treatment to decrease the prevalence of age-related cataract blindness.

Cataract surgery has evolved with time.The predominant technique practiced today in the developed countries is phacoemulsification.In the developing world phacoemulsification has had a slow uptake due to increased running costs and initial equipment costs.Manual small incision cataract surgery as popularised by Blumenthal is gradually replacing both traditional large incision extracapsular cataract surgery with intraocular lens,as well as intracapsular cataract surgery with anterior chamber intraocular lens.

South Africa has features of a developed country as well as a developing country, thus registrars are trained in all cataract surgery techniques.

I conducted a literature review looking for articles related to cataract surgery , in particular with regards to phacoemulsification and manual small incision cataract surgery.The MEDLINE and PubMed databases were searched (1957-2007) to identify English language publications dealing with visual outcomes and complications of cataract surgery.The search terms included South Africa,surgery, cataract,extracapsular,phacoemulsification, and small incision were.Of the references identified , those that were deemed worthy and suitable for review were obtained. All articles providing original data were included as well as letters to the editor and review articles.Further references were sought in the relevant articles

This search provided no published data regarding outcomes and complications of these newer forms of cataract surgery in training hospitals in South Africa.However a study by Surka and Hussein detailed the results of high volume extracapsular cataract surgery in a rural South Africa academic hospital.The predominant technique was extracapsular cataract surgery,which was performed in 93 eyes with the remaining 5 eyes undergoing intracapsular cataract surgery.Of the eyes undergoing the extracapsular technique 70 eyes received intraocular lenses with the balance remaining aphakic.Visual acuity in the operated eye revealed that 49% (45 eyes) achieved a visual acuity of 6/12 or better , with 36 of the 45 receiving intraocular lenses.Overall 92.4% of eyes achieved a visual acuity of 6/60 or better at 6 weeks postoperatively.Intraoperative complications including vitreous loss and posterior capsule rupture occurred in 7 eyes. Postoperative complications occurred in

5 eyes.The authors concluded that the rate of complications and the visual acuity outcomes were within the range of acceptable norms.

Further data and other academic centre studies would have allowed fair comparisons between institutions within South Africa.Fortunately data regarding cataract surgery outcomes has been published elsewhere and I will review important studies that highlight both the accepted rate of complications and the visual outcomes of surgery.

Wong [14]in a recent publication emphasized the role and value of cataract surgery audits.He noted that cataract surgery more than any other surgery is amenable to audit.His review of the literature revealed the following reasons for this: structure and function are closely related[15;16] , complications lead to poorer outcome[17;18] , the surgery is predictable and it is thus possible to stratify patients in terms of risk.[19;20] Limburg et al[21] reviewed the outcomes of cataract surgery in India.They found that the proportion of eyes having a poor outcome following cataract surgery (postoperative visual acuity less than 6/60) could be used to monitor outcomes regularly.They found that in the best studies[22] in the developing world the proportion with best correction in this category did not exceed 5% .When measuring surgical outcomes we should not forget that it can also be evaluated in terms of the patients' ability to function,quality of life[23;24] and economic rehabilitation.[25]

A 2007 Cochrane Review of the surgical interventions for age-related cataract added an additional dimension to the debate.[26] After reviewing the literature the authors identified 17 randomised controlled trials which investigated the 4 main forms of surgical intervention for cataract.Riaz et al[26] reported that 6 of these trials suggested that phacoemulsification gives a superior outcome to ECCE .These trials suggest a better uncorrected visual acuity,but no difference in the best corrected visual acuity. Riaz et al also reported that in a study comparing MSICS and ECCE,MSICS was advocated since it resulted in better visual acuity outcomes.Two studies[27] compared PHACO and MSICS , with PHACO showing a better uncorrected visual acuity,but no difference in best corrected visual acuity between the groups.The authors recommended further comparisons between these groups.If MSICS was found to be superior or equivalent to PHACO it would allow poor patients to have superior visual outcomes at lower cost.

Powe et al[28] published in 1994 a meta-analysis of 90 studies published between 1979 and 1991.The authors wanted to define the outcomes and risks of cataract surgery in this more modern era, in which extracapsular cataract surgery and phacoemulsification were used.They performed this task notwithstanding differences in follow-ups, variations in techniques etc.The overall number of eyes examined in all studies of visual acuity were 17390 eyes and 68316 eyes in all studies of complications.Postoperative best corrected visual acuity of 20/40 or better was achieved in 95.5% (95% CI , 95.1% to 95.9%) of eyes without ocular comorbidity and in 89.7% (95%CI ,3% to 90.2%) of those with comorbidities.These figures illustrate the great success that can be attained in the modern era.

(B)PHACOEMULSIFICATION

Phacoemulsification(PHACO) has become the most performed method of cataract extraction in the developed world.[29] It was originally described by Kelman[30] in 1967.It involved the use of a small diameter hollow needle attached to a handpiece containing a piezo-electric crystal which vibrates longitudinally at ultrasonic frequencies.The tip, while applied to the lens nucleus causes cavitation and emulsification of the lens material,an aspiration system then removes the emulsified material from the eye.A foldable intraocular lens is placed into the eye via the same incision.Phacoemulsification became popular for a variety of reasons mainly related to the small size of the incisions into the eye.Its advantages included a closed eye in which to operate,less postoperative astigmatism and early stabilization of refraction(usually 3 weeks).[29;31]

The evolution of phacoemulsification has mirrored the rapid developments both in ophthalmology and the rest of medicine in the last 40 yrs.

Phacoemulsification in its latest generation involves the use of both linear and torsional ultrasound , which is claimed to improve the efficiency and safety of the ultrasonic energy within the eye.Technological innovation has resulted in the development of microcoaxial and bimanual phacoemulsification surgery.[32] The latter now allows the surgery to be performed through incisions which are less than 1.5mm in width.[33] Intraocular lenses have evolved from hard

polymethylacrylate lenses to foldable acrylic and hema material intraocular lenses.These intraocular lenses are typically folded or injected into the eye.This speeds up visual rehabilitation[34] and the reduction of astigmatism.Currently, intraocular lenses can be placed through a less than 2mm clear corneal incision.[35]Evolution in design of intraocular lenses now allows for the use of multifocal lenses and the possibilities of patients being independent of spectacles. Advances continue at an amazing speed.

Phacoemulsification was established as a gold standard without any randomised control trial having been performed.[36] When this study was eventually performed by Minassian and associates[31] it was found that despite the additional technological costs of the technique,it resulted in more rapid visual rehabilitation and fewer hospital visits.Minassian et al[31] compared ECCE (polymethylacrylate intraocular lens) with phacoemulsification(foldable silicone intraocular lens).I will discuss their findings in the relevant subsections.

George et al[37] in a study comparing phacoemulsification , manual small incision cataract surgery and conventional extracapsular cataract surgery reported on both endothelial cell loss and surgically-induced astigmatism.They reported that the mean endothelial cell loss in the ECCE group was 4.72% , in the MSICS group 4.21% and the phacoemulsification group 5.41%.These differences between the groups did not reach statistical significance.In terms of surgically-induced astigmatism they reported that Phacoemulsification did induce less astigmatism than ECCE (0.77D vs 1.77D), but there was no difference in surgically-induced astigmatism between the MSICS group and the PHACO group($p<0.05$).A criticism of the study is the the use nonfoldable intraocular lenses in the phacoemulsification group,foldables lenses may well have favoured the phacoemulsification group.

Phacoemulsification is still out of reach to those patients in poorer countries due to high costs.Several authors have compared the MSICS technique with phacoemulsification and found that visual outcomes, quality of life scores and costs are almost as good as in phacoemulsification .[27;36;38]

This will be an ongoing debate as new studies are reviewed. Hopefully these studies will have common outcomes and measurement time points, which have been a source of criticism in previous studies.[26]

I will address the issues of resident-based surgical outcomes and complications in coming subsections.Prince et al[39] described the learning curve of an experienced extracapsular cataract surgeon to small incision scleral pocket phacoemulsification.This study was published in 1993.It used an old (now obsolete) phacoemulsification machine and a Polymethylacrylate intraocular lens , but nevertheless provides an early baseline.Visual outcomes in this 50 eye cohort were as follows : the mean best corrected visual acuity at 8 days postop was 20/40 , this remained the same at 3 weeks (median 20/30).At 3 months the best corrected visual acuity mean was 20/40(median 20/30) with 90% follow-up. Complications encountered in this cohort included corneal oedema in 14% ,posterior capsule tear in 4%,conversion to ECCE in 2% and postoperative hyphaema in 2%.The author reported that difficulties in the use of the cumbersome phacoemulsification handpiece and anterior chamber instability were also causes of intraoperative complications.

In any training hospital, surgical case selection will undoubtedly have an effect on both the visual outcomes and complications.An awareness of the density[20;40-42] of the cataract and other surgical risk factors will allow the identification of risky cases and their allocation to non-registrar surgeons.

1. <u>Visual Outcomes</u>

a. The Case for Phacoemulsification to Supersede Extracapsular Cataract Surgery.

In a landmark study Minassian et al [31] compared extracapsular cataract surgery to small incision phacoemulsification surgery. The patients were randomised to an ECCE arm (232 eyes) or to a phacoemulsification arm(244 eyes).Follow-up at 1 year was achieved in 439 eyes(88%),three months after surgery.Up to the 12 month follow-up, both uncorrected and best corrected visual acuity 6/9 or better in the phacoemulsification group were superior to

the extracapsular cataract extraction group.The uncorrected visual acuity 6/9 or better was achieved in 87 eyes(39%) and 42 eyes(205) in the phaco and ECCE groups at 1 year respectively($p<0.001$).This difference was statistically significant at follow-up interval.Best corrected visual acuity 6/9 or better was achieved in 204 eyes(91%) and 184 eyes(86%) in the phaco and ECCE groups at 1 year respectively($p=0.0076$).This difference was statistically significant at earlier follow-ups.Reviewing the visual acuities at all earlier follow-up visits the authors concluded that the phaco group attained a good stable level of acuity sooner (by the third postoperative week),the ECCE group continued to improve up to 6 months,but the visual acuity remained poorer in the ECCE group.Astigmatism was a significant contributor to the poorer visual outcome in the ECCE group.The authors concluded that phaco was superior to ECCE.One of the weaknesses of this study was the exclusion of brunescent cataracts.This has particular relevance to the developing world where advanced cataract presentations are more common.

b. Visual outcomes in training environments

Allinson et al[43] reported in 1992 on a study involving 136 phacoemulsification cases undertaken by 6 registrars with a single supervisor.They reported visual acuity in those cases that had vitreous loss. In the 20 eyes in which vitreous loss occurred, 14 eyes (73.7%) had a postoperative visual acuity of 20/40 or better at the 2-4month visit.Visual acuity of 20/50 or worse occurred in 5 eyes of which three were attributed to the presence of cystoid macular oedema.Cruz et al[44] reported on the visual results and complications of phacoemulsification surgery by residents in 181 cases.An evolution in technique had occurred in that Cruz et al[44] used the in situ fracture techniques.Notwithstanding the 9.9% posterior capsule rupture rate, the majority of intraocular lenses were placed firstly into the ciliary sulcus and secondly into the bag.In the group without vitreous loss 84.5% were placed in these positions and in the vitreous loss group this occurred in 90% of cases.Best corrected visual acuity overall was 20/40 or better in 92.6% of eyes at 6 months.In the 18 eyes with posterior capsule rupture best corrected visual acuity of 20/40 or better was achieved in 16 eyes(89%).Of

the remaining two eyes one developed cystoid macular oedema and the other had a preexisting subretinal neovascular membrane.Other authors have reported that between 88-89% of eyes overall achieved best corrected visual acuity of 20/40 or better in their early phacoemulsification studies with trainee surgeons.[44;45]

Zaidi et al[46] reported on an audit of 1000 patients undergoing cataract surgery at a large teaching hospital , the Western Eye Hospital ,London ,United Kingdom.They felt that a new benchmark was needed , in that the previous United Kingdom benchmark,the 1997-1998 National Cataract Surgery Survey(NCSS) was almost 10 years old. Zaidi et al reported that all surgeries involved either consultant supervision or consultant-performed surgery. Trainees acting as the primary surgeon included senior house officers(25.5%) , specialist registrars(41%) and fellows(17%).Consultants acted as the primary surgeon in 16.5% of cases. Local anaesthesia was used in 92% of the surgeries. Preoperative uncorrected visual acuity was 6/36(mode). Postoperative uncorrected visual acuity was 6/9(mode). Improvement of best corrected visual acuity to 6/12 or better occurred in 93% of patients. Refractive outcomes indicated that over 80% of cases were within +-1dioptre of target refraction.The study at the Western Eye Hospital used significantly better technologies than those used during earlier studies.

Riley et al[47] reported on a prospective observational study conducted in the largest teaching hospital in New Zealand. The majority of the procedures were phacoemulsification cases(97.3%).Preoperative mean visual acuity for the operated eyes was 6/48+1.Postoperative uncorrected visual acuity at 4 weeks showed that 67.7% of eyes achieved 6/12 or better, with 12.1% achieving 6/6 or better.Postoperative best corrected visual acuity in 421 eyes(88%) was equal to or greater than 6/12, with 1% achieving less than 6/60.Postoperative change in astigmatism was less than or equal to 1.5D in 84.6% of eyes.

c. Visual outcome in a variety of environments ,both private practice and training hospitals.

Lundstrom et al[48] reported in 2001 , on the outcomes of the 1998 European Cataract Outcome Study,which involved 31 surgical units in 13 European nations.

i. Median Preoperative visual acuity in the operated eye was a 0.3 (snellen equivalent =6/20) and 0.6 (snellen equivalent=6/10) in the fellow eye.This was similar to other United States studies[49] and better than some European studies.[50]

ii. Postoperative visual acuity of 0.5 or better(6/12 or better) was achieved in 85.4% of cases , in those without preoperative ocular comorbidity then increased to 93.5%.The overall rate of 85.4% with a visual acuity 0.5 or better , is comparable to Wegener et al[51] 87.1% , Schein et al[49] 93% and Desai et al[52] 92%.

iii. In terms of refractive outcomes , in 77.7% of all cases(Range between units 56% to 92.9%),the final refraction was within +-1.0 dioptre of the target refraction.Other studies have quoted rates from 67-83% attaining a similar target.[48]The mean values of induced astigmatism using three methods were 0.6 dioptre,0.94 dioptre and 0.77 dioptre.[48;53]

(C)MANUAL SMALL INCISION EXTRACAPSULAR CATARACT SURGERY (MSICS)

Manual small incision cataract surgery was first popularised by Blumental in 1994 .[54] Girard et al[55-57] described using a small tunnel for extracapsular cataract surgery in 1984.It was the natural evolution in training for surgeons who had been familiar with large incision extracapsular cataract techniques.There is great interest in the technique in developing countries where phacoemulsification is expensive and the volume of cataract surgery needed is vast.It is thought to offer the benefits of phacoemulsification, which include rapid visual recovery and reduced astigmatism.[57;58] Variations in technique of nucleus removal,tunnel

construction and capsulotomy will also affect visual outcome and complications. Any attempt to compare outcomes of phacoemulsification to MSICS would need a large sample size to confidently conclude that one treatment is superior to the other. [36]

In addressing the visual outcomes and complications of cataract surgery I will refer to two recent expert-based studies by Hennig et al[59] and Venkatesh et al [60], which were published in 2003 and 2005 respectively.Two trials by Ruit el al[38] and Gogate et al[27] will also be addressed.These studies are expert based and thus not performed by trainees, thus they may not necessarily reflect the outcomes by a trainee.

1. Visual Outcomes

a. Hennig et al[59] conducted a study on 500 eyes in Nepal using the sutureless manual small incision cataract technique with fish-hook nucleus extraction. This study used surgeons who were highly experienced in the technique and excluded eyes with known comorbidities.Intraoperative complications included 47 eyes (9.4%) with hyphaema and 1 eye having posterior capsule rupture with vitreous loss(0.2%).Postoperative complications needing a second procedure occurred in 6 eyes(1.2%).At 1 year , only 134 patients presented out of 150 patients who had been asked to return: 3 eyes(2.2%) had developed visually significant posterior capsule opacification.Hennig et al have reported on the excellent results which can be achieved with the technique.Of further importance in developing countries was that the mean duration of surgery was 4 minutes and average cost of consumables was $10.

i. Prior to surgery nearly all eyes were blind (96.8%) , or were severely visually impaired. This was reduced to less than 1% by discharge.

ii. The Uncorrected Visual acuity in this study on day 2 after surgery was 6/18 or better in 76.8% of eyes.This declined to 70.5% at 6 weeks and then to 64.9% at 1 year.

iii. The best corrected visual acuity was 6/18 or better in 96.2% of eyes at 6 weeks and 95.9% at 1 year.

iv. Poor Visual outcome which, is defined as a best corrected visual acuity less than 6/60),was present in 0.2% of eyes at 6 weeks and in zero eyes at 1 year follow-up.This low proportion was probably due to excluding eyes with comorbidites and the low rate of operative complications.

v. The role of astigmatism affecting uncorrected visual acuity was discussed by the authors.Keratometry was performed and induced astigmatism was calculated using Holladay's [61]method at 6 weeks and at 1 year.The authors noted that there was a statistically significant drop in eyes achieving 6/18 or better at discharge than at 6 weeks.They felt that this was due to increasing astigmatism.At six weeks 85.5% of eyes had "against the rule" astigmatism, with a mean induced cylinder of 1.41D(standard deviation 0.8D).This increased at 1 year by a further 0.66D(Standard deviation 0.41).

b. Venkatesh et al[60] in a study at Aravind Eye Hospital in India reviewed the outcomes of 594 patients who had cataract surgery by three experienced high volume surgeons.In this series 582 eyes(98%) underwent manual small incision cataract surgery.The manual small incision cataract surgery technique was modified with delivery of the nucleus using an irrigating vectis."High volume surgeons" were defined as surgeons performing more than 80 surgeries per day in six operating hours.As opposed to the study by Hennig et al , patients with ocular comorbidities were not excluded.This makes this study a better indication of real world practice.The average time per surgery was around 3.75 minutes.This confirms the cost and time effectiveness of the technique as described by Hennig et al.

i. Prior to surgery nearly all eyes were blind (88.5.%).This was reduced to less than 6% by discharge.

ii. The uncorrected visual acuity in this study on day 40 after surgery was 6/18 or better in 228 eyes(43.9%), an uncorrected visual acuity of less than 6/60 was achieved in 27 patients(5.3%).Follow-up on day 40 was achieved in 88% of cases.The uncorrected visual acuity 6/18 or better in 43.9% was significantly worse than the 70.5% reported by Hennig et al.However, it is in keeping with the findings reported by Gogate et al[62], who performed a

randomised trial comparing ECCE and manual small incision cataract surgery.

iii. On day 40 the best corrected visual acuity was 6/18 or better in 491 patients(94.4%).A best corrected visual acuity of less than 6/60 was achieved in 8 patients(1.6%).Pre-existing ocular pathology was the most common reason for poor best and uncorrected visual acuity.The reported best corrected visual acuity outcome in the 6/18 or better category is in agreement with findings of Hennig et al.They also compare favourably to the findings of Powe et al[28] in their analysis of over 90 studies of cataract surgery.

iv. The impact of astigmatism as a source of poor uncorrected visual acuity was not investigated in this study.

c. Gogate et al[27] reported in 2004 on the 6 weeks outcome of a randomised control trial comparing phacoemulsification to manual small incision cataract surgery.A total of 400 eyes were randomised and the surgery was performed by expert surgeons.

i. Postoperative uncorrected visual acuity at 6 weeks was better or equal to 6/18 in 150 of 185 phaco eyes(81.08%) and 133 of 187 MSICS eyes(71.1%)(p=0.038).

ii. Postoperative best corrected visual acuity at 6 weeks was better or equal to 6/18 in 182 of 185 eyes(98.4%) and 184 of 187 MSICS eyes(98.4%)(p=0.549).

iii. Poor outcome of visual acuity less than 6/60 occurred in 1 eye of the phaco group(0.5%) and in zero eyes in the MSICS group.

iv. Postoperative astigmatism between the groups at six weeks was not statistically different,with a mean of 1.1dioptre in the phaco group and 1.2dioptre in the MSICS group.

d. Ruit et al[38] reported in 2006 on the 6 month outcomes of a randomised control trial comparing phacoemulsification to sutureless manual small incision cataract surgery.In total 100 eyes were randomised and the surgery was performed by expert surgeons,in an expert based trial.[36] Criticisms of the

study included the ball randomisation technique,the small number of cases and the short follow-up time.

i. Preoperative visual acuity was similar in the phaco and the MSICS group. In the phaco group 12 out of 54 eyes(22.2%) had an uncorrected visual acuity of hand motions or worse,and 13 of 54 eyes(24.1%) in MSICS group with the same vision.

ii. Post operative visual acuity at 6 months was reported as being excellent, with no statistical difference between the groups.At 6 months uncorrected visual acuity in the phaco group was 20/60 or better in 85% of cases and in the MSICS was the same in 89% of cases.Best corrected visual acuity at 6 months was 20/60 or better in 98% of the MSICS groups and phaco group. Best corrected visual acuity at 3 weeks in the phaco group was superior to the MSICS group.The results for both uncorrected and best corrected visual acuity are superior to those obtained by Hennig and Venkatesh.[59;60]

iii. Postoperative Keratometric Astigmatism was reported to average 0.88dioptre in the MSICS group and 0.7dioptre in the phaco group.

(D)INTRACAPSULAR CATARACT SURGERY(ICCE)

Intracapsular cataract surgery proved to be popular till the early 80's. [26] It was widely used and continues to be used in certain developing countries.Typically these patients have severe visual impairment.Kapoor et al[63] in a large Indian study where over 50% of the surgery performed was intracapsular, noted that 94.8% of patients had preoperative visual acuity of less than 3/60 in the index eye and 41% of surgeries were performed on bilaterally blind eyes.Prajna et al[64;65] in a study at Aravind Madurai found that more than 75% of the treated eyes had a preoperative visual acuity of 20/600 or less .

Intracapsular cataract surgery involves the removal of the entire lens capsule with the zonules from the eye.The patient is visually rehabilitated through the insertion of an anterior chamber intraocular lens, the use of aphakic glasses or contact lenses.It was a technique that allowed rapid surgical times of less than 5

minutes and also lent itself to an easier training path.Acheson et al[66] reported in 1988 on their experience at a large teaching hospital in the United Kingdom during the years of the changeover from intracapsular cataract surgery to extracapsular surgery with posterior chamber intraocular lenses.They noted that vitreous loss rates experienced with ICCE were 5-6% , and with the introduction of ECCE ,it dropped to 2%.Secondary glaucoma dropped from 13-28% in the ICCE years to less than 8% in the ECCE group.They concluded that the pattern of complications had changed with the move to ECCE with fewer posterior segment complications and increased posterior capsule opacification.ICCE still has a role in the modern era in the setting of trauma with extensive zonulysis. Visual rehabilitation in this setting can then be completed with aphakic glasses or an anterior chamber intraocular lens.In 1995 Ellwein et al[9] have noted that extracapsular cataract surgery with intraocular lens has almost entirely replaced intracapsular cataract surgery in the developing world.

1. Visual Outcomes

Cook et al[67] in a study on rural blacks with ICCE and anterior chamber intraocular lens reported that at 6 months 67% reported a best corrected visual acuity of 6/18 or better , and there were none with a visual acuity less than 6/60.

Waddell et al[68] in a more recent rural African study published in 2004 performed a randomised control trial comparing extracapsular cataract surgery with posterior chamber intraocular lens and ICCE with anterior chamber intraocular lens.At 1 year of follow-up there was no statistically significant difference in visual acuity between the groups.The ICCE and anterior chamber intraocular lens group had 80% of eyes with best corrected visual acuity of 6/18 or better,the ECCE and posterior chamber intraocular lens groups achieved a visual acuity of 6/18 or better in 82% of eyes.Final visual acuities were similar in both groups however the ICCE group had a higher rate of secondary procedures or complications (16% vs 8%).Waddell concluded that extracapsular cataract surgery with posterior chamber intraocular lens was preferable.

These findings are similar to the studies of both Snellingen et al[69] and the "Lahan" study of Hennig et al.[70;71] Snellingen et al performed a randomised control study in South Asia comparing the outcomes of ICCE with anterior

chamber intraocular lens and ICCE with aphakic glasses.At 2 years after surgery best corrected visual acuity was 6/18 or better in 88.8% of the intraocular lens group and 86.6% of the group with glasses.Hennig et al followed up 1827 cases in Nepal who had had ICCE with and without intraocular lens.At 1 year follow-up 89.9% and 93.2% with and without intraocular lens had a best corrected visual acuity of 6/18 or better.

Hennig et[70] al reported severe visual impairment in 1.8% at 6 weeks and 2.6% at 1 yr, in the Pseudophakic group.At 1 year 1.6% of patients were noted to be blind.The commonest causes of poor visual outcome at 1 yr in the anterior chamber intraocular lens group (visual acuity less than 6/60) were uveitis, secondary glaucoma,cystoid macula oedema,endophthalmitis and later corneal ulcer.

(E)EXTRACAPSULAR CATARACT SURGERY

Extracapsular cataract surgery was reintroduced into the modern era with advances in microsurgical technique in the 1980's.[26] It has been instrumental in allowing large numbers of patients to be visually rehabilitated.This technique was superior to the previously standard intracapsular cataract technique in that it eventually allowed the placement of an intraocular lens into the lens bag or the ciliary sulcus, allowing faster visual rehabilitation and avoiding the complications of the older designs of anterior chamber intraocular lenses. Disadvantages of the technique include posterior capsule opacification and obstruction, which needs further treatment at a later stage.

Acheson et al[66] reported in 1988 on their experience at a large teaching hospital in the United Kingdom during the years of the changeover from intracapsular cataract surgery to extracapsular surgery with posterior chamber intraocular lenses.They compared earlier and later groups of intracapsular and extrapsular surgeries.Of note to trainees and to the less experienced was that they achieved a vitreous loss rate of 2% in the extracapsular group.Corneal oedema at 3 months was noted to occur in 6% , and a visual acuity of 6/12 and better in 72-75% of eyes(the latter being in a later group of ECCE patients)

1. Visual Outcomes

a. Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens collected data on 461 surgeries at Kikuyu Hospital in Kenya. Kikuyu Hospital is a training facility , thus this study will reflect outcomes in an African teaching environment. These surgeries were predominantly performed on patients of African ethnic origin in 85% of cases and the balance were in East African Asians. Preoperatively 390 eyes(84.6%) were blind with a best corrected visual acuity below 3/60.Postoperatively an uncorrected visual acuity of 6/18 or better was achieved in 78.2% of eyes,and best corrected visual acuity of 6/18 or better was achieved in 94.3% of eyes.Six eyes (1.5%) had a poor visual outcome with a visual acuity of less than 6/60.These findings exceed WHO standards in blindness alleviation programmes.Follow-up at 4 weeks was achieved in 404 eyes (87.6%) and at 2 years in 95 eyes(20.6%).This is in keeping with other developing world studies.The authors also reviewed the keratometry readings at 2 months and reported that the average astigmatism was 1.53D, and fifty four eyes (15.6%) had more than 2 dioptres of astigmatism.The complications encountered in this study are dealt with in the relevant subsections.

b. Browning and Cobo[45] in 1992 reported on residents' initial experience with extracapsular cataract surgery.Preoperative visual acuity in this group was 20/200 or worse in 89% of patients.Postoperative best corrected visual acuity in the extracapsular cataract extraction group with intraocular lens was greater than or equal to 20/40 in 89% of cases.Visual results deferred between registrars and supervisors , with one registrar achieving 20/40 or better in all his cases.The authors reported that only 3% of eyes had greater than 2 dioptres of astigmatism preoperatively whereas 22% of eyes had postoperative astigmatism greater than two dioptres.

(F)COMPLICATIONS OF CATARACT SURGERY

Modern cataract surgery has evolved into a safe procedure with limited complications .[5]

In the following discussion I will tabulate the more common complications of cataract.They will be subdivided into categories,other authors may categorise these complications in an alternate manner(Table 1b)

I will then elaborate on the important ones drawing distinctions in complication rates between the various surgical techniques.I will focus particularly on providing data regarding the phacoemulsification and MSICS techniques.No attempt will be made to classify the complications into schemes similar to the grading and scoring systems used by the Oxford Cataract Treatment and Evaluation Team.[73;74]

I will also present data related to older studies as well the improvement in complication rates associated with newer modifications.Data related to specific studies looking at registrars in training will also be presented.

Table 1b Complications of cataract surgery by subcategory

COMPLICATION CATEGORY	**SUBCATEGORY**	**COMPLICATION**
INTRAOPERATIVE COMPLICATIONS	*WOUND RELATED*	Tunnel perforation
		Phacoemulsification thermal burns
		Descemet's membrane detachment
	ANTERIOR SEGMENT COMPLICATIONS	Capsule rupture with/without vitreous loss
		Iris damage
		Haemorrhage
	POSTERIOR SEGMENT COMPLICATIONS	Choroidal haemorrhage

		Nuclear or nuclear fragment loss into posterior segment
		Posterior dislocation of intraocular lens
<u>POSTOPERATIVE COMPLICATIONS</u>	*EARLY POSTOPERATIVE*	Cystoid macular oedema
		Endophthalmitis
		Corneal oedema
		Raised intraocular pressure
		Vitreous in wound
		Wound dehiscence and leakage
		Hyphaema
		Postoperative uveitis
		Toxic anterior segment syndrome
		Malposition of an intraocular lens
		Hypotony with choroidal effusion
		Postoperative astigmatism
		Postoperative refractive suprise
		Retained lens cortex
	LATE POSTOPERATIVE	Posterior capsule opacification
		Delayed chronic postoperative endophthalmitis

		Corneal oedema and Bullous keratopathy
		Glaucoma
		Retinal detachment
		Intraocular lens related problems including opacification

1. INTRAOPERATIVE COMPLICATIONS

a. Anterior segment complications

i. Capsule rupture with or without vitreous loss

Vitreous loss is defined as the rupture of the posterior capsule or zonule followed by rupture of the anterior hyaloid face with presentation of vitreous anterior to posterior capsule plane.[75]Vitreous loss is recognized as an extremely serious complication of cataract surgery.Vail[76] has previously documented the poor long-term results associated with untreated vitreous loss.He reported a 7.3% incidence of retinal detachment and 13.1% incidence of secondary glaucoma. Maumenee[77], Kasner and Gass[78] fortunately innovated and developed techniques for dealing with vitreous loss progressing from aspiration to cellulose sponge assisted vitrectomy.Peyman and Sanders[79;80] ultimately advocated a closed system of automated anterior vitrectomy,modifications of which are still used today.Berger et al[81] reported that in an early series in 1980 in a teaching hospital,where patients were treated with an early vitrector system or a swab vitrectomy,they had a 3% retinal detachment rate and 10% incidence of glaucoma.

1. Phacoemulsification

Kelman,the founding father of phacoemulsification surgery reported a 16% incidence of vitreous loss in the first 50 eyes undergoing phacoemulsification.[30;82;83] Gimbel[84],an experienced phacoemulsification

surgeon, published a comprehensive study on posterior capsule tears and their management. He had an incidence of posterior capsule tear of 0.5% in a study of 7169 eyes.His vitreous loss rate was 0.27% in the same study.

In an early report of vitreous loss in residents,Cotlier and Rose[85] reported in 1976 an incidence of 14.2% amongst residents performing 5 or more procedures , with an incidence of 31.5% in residents who had performed fewer than 4 phacoemulsification procedures.Allinson et al[75] reported in 1992 an incidence of vitreous loss of 14.7% in 136 phacoemulsification cases ,in a study of 6 registrars with 1 supervising surgeon.The evolution of techniques , teaching and equipment would most probably be the cause of this improvement.The following report in 1992 by Cruz et al[44] reported on the visual results and complications of phacoemulsification surgery by residents in 181 cases.An evolution in technique had occurred in that Cruz et al used the in situ fracture techniques.They reported that posterior capsule rupture incidence was 9.9%(18 eyes) with 72% occurring during the cortical removal stage.Vitreous loss occurred in 5.5% of cases. This was a marked improvement from 14.7% reported by Allinson et al. Allinson et al[43] in a letter to the editor reported that with modification of the technique,their residents had also managed to reduce their vitreous loss rate.Other early authors of resident phacoemulsification studies have reported vitreous loss rates of 2.9% ,4.8%, 6.8% , and 9%.[44;45;86;87]Olson et al [88]reported in a study comparing the first 50 resident cases with the last 50 cases of their training.They found that the overall vitreous loss rate was 1.8% and twenty complications occurred in 396 cases(5.1%).Posterior capsule rupture without vitreous loss occurred in 1%.Amongst the four residents there was a statistically significant difference between the registrar with the highest and lowest intraoperative and postoperative complications ($p<0.05$).There was also a statistically significant difference between the early vitreous loss rate of 2.6% and 0% late vitreous loss rate ($p<0.02$).Both individual skill and increasing skill impact on the complication rate.

Zaidi et al[46] reported on an audit of 1000 patients undergoing phacoemulsification cataract surgery at a large teaching hospital,the Western Eye Hospital,London,United Kingdom. In their study the total incidence of

complications was 8.7%.Posterior capsule rupture with vitreous loss occurred in 1.1% , with one of these cases progressing to dropped nucleus and two to postoperative retinal detachment.Posterior capsule rupture without vitreous loss occurred in 0.4% of cases.Complication rates were lowest in consultants(0.1%) , then house officers(2%),fellows(4.5%) and highest in specialist registrars(6.5%). The finding of higher complication rates amongst more experienced trainees, may be explained by case selection bias where they chose more complex cases than more junior trainees.The posterior capsule rupture is lower than the 4.9% reported by Riley et al in a prospective observational study conducted in the largest teaching hospital in New Zealand.

Smith et al[89] in an earlier study on residents in all years of training using both extracapsular surgery and phacoemulsification reported that overall experience and not necessarily the surgical technique were factors related to complications in the residents' hands.Tarbet et al[90] in their study on residents reported a vitreous loss rate of 3.3%.They concluded that proper supervision and case selection are important to limit complications in early training.Tayanithi et al[91] reported on a case control study comparing vitreous loss rates between third year residents and faculty.The vitreous loss rate among residents was 6.93% (28/404) and in faculty was 2.06%(28/1358).The authors concluded that residents have a four times higher risk of intraoperative vitreous loss during phacoemulsification when compared to faculty (p=0.0052).They recommended that vitreous loss rates may provide feedback regarding the adequacy of a cataract surgery training programme.

Minassian et al [31]reported in 2001 on a landmark study comparing extracapsular cataract to small incision phacoemulsification surgery.The posterior capsule rupture (with/without vitreous loss) rate was 4% in the ECCE group and 3% in the phaco group(p=0.808)

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.The authors wanted to define the outcomes and risks of cataract surgery in this more modern era, in which extracapsular cataract surgery and phacoemulsification were used.In the phaco group the proportion of posterior capsule rupture varied between 0.46% and 3.9% , and in the ECCE group

between 0% and 8%.Vitreous loss in the phaco group varied from 0 to 0.5% , and in the ECCE group from 0% to 4%.

2. MSICS

Hennig et al[59] reported on an expert based study using the sutureless manual small incision cataract technique with fish-hook nucleus extraction.They reported a single episode (0.2%)of posterior capsule rupture with vitreous loss.This would be the ideal.

Venkatesh et al[60] reported 11(1.9%) intraoperative complications in 593 patients in an expert based MSICS study.Posterior capsule rupture with no vitreous loss occurred in 4 eyes(0.7%),posterior capsule rupture with vitreous loss occurred in 4 eyes(0.7%) ,and zonular dialysis(without vitreous loss) in 3 eyes(0.5%).This study did not exclude patients with ocular comorbidities as the former has done.

Gogate et al[27] reported in 2005 on a trial comparing phacoemulsification to manual small incision cataract surgery.Posterior capsule rupture was 6% in the MSICS group compared to 3.5% in the phaco group.

Ruit et al[38] reported in 2006 on the 6 month outcomes of a expert based randomised control trial comparing phacoemulsification to sutureless manual small incision cataract surgery.There were no cases of posterior capsule rupture in the MSICS group (54 eyes) and there was a single case with vitreous loss in the phaco group(54 eyes).

Kothari et al[17] reported in 2003 on an Indian training hospital study of 2095 eyes which had undergone predominantly MSICS (1455 eyes).They reported on the cases with vitreous loss which were matched to controls without vitreous loss. Vitreous loss occurred in 160 eyes(7.3% ; Confidence interval 7 to 9.3%). Subgroup analysis showed that vitreous loss occurred in 8.3% of the ECCE group, 8.1% of the MSICS group and 5% in the phaco group.Visual outcomes of 6/18 or greater were achieved in 85% of vitreous loss cases and in 95% of controls.This difference was statistically significant ($p<0.05$).This experience of poorer outcomes in cases of vitreous loss, even if well managed has been previously documented.However, in this study experienced surgeons showed

better outcomes even in the vitreous loss cases,which points to their improved handling of these cases.Patients with a poor visual outcome of <3/60 had a 5% incidence.

Lundstrom et al[48] reported in 2000,on the outcomes of the 1998 European Cataract Outcome Study,which involved 31 surgical units (including training units) in 13 European nations.In this study of 2950 eyes,which mainly underwent phaco(94.8%),intraoperative complications occurred in 3.5% of cases.Posterior capsule rupture occurred in 2.2% of cases,vitreous loss occurred in 1.5% of cases.

3. Intracapsular Cataract Surgery

In a study published in 1998 Cook et al[67] performed a pilot study looking at the applicability of anterior chamber intraocular lenses in a rural black population . They had a vitreous loss rate of 16% which the authors felt was due to inexperience with the new technique of intraocular lens.Snellingen et al in a South Indian randomised control study comparing ICCE with anterior chamber intraocular lens and ICCE with aphakic glasses had an overall vitreous loss rate of 10.3%,with a higher rate of 11.2% in the intraocular lens group.

4. Extracapsular Cataract Surgery

Claoue et al[92] in a 1993 review of 2588 eyes undergoing predominantly ECCE surgery noted that there was a vitreous loss rate of 1.7%.[92] At that time other studies had noted rates of vitreous loss from 2.4%(resident surgery study)[93] to 4.3% .[94] Of note is that the aforementioned study covers eyes that underwent surgery during the transition from anterior chamber intraocular lenses to posterior chamber intraocular lenses,however out of 43 vitreous losses,only 1 was attributed to iol insertion.

Pearson et al[86] reported in 1989 on a retrospective review of 936 extracapsular cataract surgeries performed by residents at a large teaching hospital.They compared two time frames ,1982 to 1985 and 1985 to 1988.In the initial period the incidence of vitreous loss was 10.3% and in the second period the vitreous loss rate was 3.2%.The authors reported that at the beginning of 1985 , the trainees were supervised by full-time faculty,whereas previously this was done by part-time surgeons.This familiarity with both the preoperative assessment and

the residents' skills,allowed for this significant improvement to occur.The authors concluded that close supervision in both early and more experienced trainees would keep the complication rate within an acceptable level.The vitreous loss rate of 3.2% attained in the second period was favourable when compared to Browning and Cobo[45] 9% in extracapsular resident surgery and Jaffe's[95] 9.9% in his early experience with extracapsular surgery.

Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens collected data on 461 surgeries at Kikuyu Hospital in Kenya. Kikuyu Hospital is a training facility,thus this 1999 study reflects outcomes in an African teaching environment.They documented a posterior capsule rupture rate of 33 eyes(7.2%).Vitreous loss occurred in 19 eyes (4.6%).

Other African studies have reported posterior capsule rupture rates of 10% in Ghana[96] and 11.4% in Sierra Leone.[97]

Browning and Cobo[45] in 1992 reported on residents' initial experience with extracapsular cataract surgery.In the residents' first twenty five cases, the posterior capsule rupture rate was 16% and vitreous loss occurred in 9%.One resident had a 30% posterior capsule rate and another 0%.This illustrates the individual learning curve with surgical techniques.In the two subgroups of interest , 67% of eyes with vitreous loss attained 20/40 or better,and 76% of eyes with a posterior capsule rupture attained 20/40 or better.The authors concluded that both the visual results in the complicated as well as the uneventful cases,was within the acceptable norm.

ii. Iris damage

1. Phacoemulsification

Olson et al [88] in 1998 reported on a study comparing the first 50 resident cases with the last 50 cases of their training.They reported a zero incidence of iris trauma.

Zaidi et al[46] reported on an audit of 1000 patients undergoing phacoemulsification cataract surgery at a large teaching hospital , the Western Eye Hospital ,London ,United Kingdom.Iris Trauma occurred in 12 cases (1.2%)

Minassian et al [31]reported in 2001 that iris trauma occurred in 2% of the ECCE group and 1% of the phaco group.

Powe et al[28] reported that iris trauma in the phaco group varied between 0.5% to 7.8% , in the ECCE group between 0% to 9.1%.

2. MSICS

Hennig et al and Venkatesh reported no cases of iris trauma.[59;60]

iii. Anterior segment haemorrhage e.g. hyphaema

1. Phacoemulsification

Zaidi et al[46] reported 1 hyphaema(0.1%) in a 1000 patient training hospital audit.

2. MSICS

Hennig et al[59] conducted a study on 500 eyes in Nepal using the sutureless manual small incision cataract technique with fish-hook nucleus extraction.They reported that in 47 eyes(9.4%) there was bleeding from the scleral tunnel into anterior chamber intraoperatively.

Venkatesh et al[60] did not comment on intraoperative hyphaema occurring in their series of 593 patients in an expert based MSICS study

b. Posterior segment complications

i. Choroidal haemorrhage

Minassian et al [31]reported in 2001 on a landmark study comparing extracapsular cataract to small incision phacoemulsification surgery.They reported 1 case in each group having a choroidal haemorrhage , 0.4% in both the PHACO and ECCE groups.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.They reported no choroidal haemorrhage in the PHACO group and in the ECCE group the proportion varied from 0% to 2% ,with a pooled result of 0.3%

ii. Nuclear or nuclear fragment loss into the posterior segment

Riley et al [47] in a prospective observational study conducted in the largest teaching hospital in New Zealand , reported that posterior capsule rupture with lens fragments dropped occurred in 4 eyes of 488 PHACO eyes(0.8%)

Gogate et al [27]reported in 2005 on a randomised control trial comparing phacoemulsification to manual small incision cataract surgery.They reported a single dropped nucleus out of 199 phaco cases.This case was treated by vitrectomy.

Lundstrom et al[48] reported in 2000 , on the outcomes of the 1998 European Cataract Outcome Study,which involved 31 surgical units (including training units) in 13 European nations .In this series of 2950 eyes,they reported a dropped nucleus in 0.2%.

2. EARLY POSTOPERATIVE COMPLICATIONS

a. Cystoid Macular Oedema

Cystoid macular oedema is recognized as the leading cause of poor visual outcome after uncomplicated cataract surgery.It usually occurs 4-12 weeks after cataract surgery.Clinical cystoid macular oedema is characterised by decreased visual acuity with a characteristic change in the macular appearance. Angiographic cystoid macular oedema is the presence of leakage of fluorescein in the macular areas with clinical cystoid macular oedema.

1. Phacoemulsification

The incidence of clinical cystoid macular oedema in uncomplicated phacoemulsification surgery has been reported to be 0% by Ursell et al[98] in 1999.Angiographic studies have reported the incidence to be between 5.7 to 19%.[98;99] In the largest study to date by Mentes et al[100], in 252 uncomplicated phacoemulsification eyes,no clinical cystoid macular oedema was found and the incidence of angiographic cystoid macular oedema was 9.1% at 45 days.This

suggests that the incidence of cystoid macular oedema in uncomplicated phacoemulsification cases is lower than that seen in intracapsular cataract surgery and extracapsular cataract surgery.

Zaidi et al[46] reported 11 cases of clinically apparent cystoid macular oedema (1.2%) in a 1000 patient training hospital phacoemulsification audit,which had a mean follow-up of 48 days.This is lower than the 3.7% reported by Riley et al in a prospective observational study conducted in the largest teaching hospital in New Zealand.

Minassian et al [31]reported in 2001 on a landmark study comparing extracapsular cataract to small incision phacoemulsification surgery.Cystoid macula oedema occurred in 3 eyes(1%) in the phaco group and 2 eyes(1%) in the ECCE group.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991 .The authors wanted to define the outcomes and risks of cataract surgery in this more modern era, in which extracapsular cataract surgery and phacoemulsification were usedThe proportion of patients with clinically apparent cystoid macular oedema in the phaco group varied from 0.6% to 6.0% , for ECCE from 0% to 7.6%.The pooled result for phaco was 2.3% and for ECCE 1.5% , with no significant statistical difference between the groups. Angiographic cystoid macular oedema was found to be lower in phaco at 2.62% than for ECCE 8.91%.This was statistically significant($p<0.05$).

2. MSICS

Kothari et al[17] reported in 2003 on an Indian training hospital study of 2095 eyes which had undergone predominantly MSICS (1455 eyes).Vitreous loss occurred in 160 out of 2095 eyes(7.63%).Prevalence of clinically apparent cystoid macular oedema was 11.35%(16 of 141 eyes) in those with vitreous loss versus 5.67%(8 of 141 eyes) in the control group.

3. Intracapsular Cataract Surgery

Powe et al in a review of 90 studies of various forms of cataract surgery noted that cystoid macular oedema occurred in 0% to 7% of eyes.[28] In the "Lahan" study Hennig et al[70] diagnosed cystoid macular oedema in 1.6% of the pseudophakic group and 1% of the aphakic group.Notwithstanding the uveitis

associated with iol implantation ,the authors felt that this was as a result of the ICCE technique.This is supported by the study by Prajna[64] et al who compared ICCE with aphakic glasses with ECCE (and posterior chamber intraocular lens). At 2 months 2.5% of ICCE group had cystoid macula oedema and only 1.7% of the ECCE group.Mentes et al[100] reported that the incidence of clinical cystoid macular oedema was 2-7.6% in a number of studies.[101;102] The use of an iris plane intraocular lens increased the incidence of cystoid macular oedema to between 6-23%.[103-105]However angiographic cystoid macular oedema in ICCE surgery has an incidence of 36-60% .[106;107] The variability in the rates of cystoid macular oedema between the various studies could be related to both their definition of the condition and whether fluoroscein angiography was performed. Of note is the fact that the angiographic severity does not necessarily correlate with the visual acuity.[100]

4. Extracapsular cataract Surgery

Frost et al[18] in an early study comparing the outcome of extracapsular cataract extraction with vitreous loss and ACIOL to extracapsular cataract surgery with PCIOL reported that there was a statistically significant incidence of clinical cystoid macular oedema amongst eyes with vitreous loss compared with controls (20% vs 1% , P=0.00021) This led to a statistically significant poorer visual outcome. Both these findings have previously and since been described in the literature.[18]

Mentes reported that the advent of ECCE with posterior chamber intraocular lens has greatly reduced the incidence of clinical cystoid macular oedema to between 0.8-3.5%.[108;109]Angiographer incidence is lower than the intracapsular group at between 10-20%.[110;111]

Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens collected data on 461 surgeries at Kikuyu hospital in Kenya.They documented 5 cases of cystoid macular oedema , in a study where follow-up at 2months occurred in 346 eyes(75.1%).

b. Endophthalmitis

Endophthalmitis is a devastating ocular complication.It is regarded as one of the most serious complications of cataract surgery.Endophthalmitis has historically had a 0.1% or lower incidence .[112;113] The ESCRS study on antibiotic prophylaxis, a recent large prospective European study has estimated that the actual background endophthalmitis rate is approximately 0.38%.This is much higher than the 0.1% mentioned previously.Endophthalmitis has been reported at lower rates due to the tendency for retrospective studies to underestimate incidence rates.[114]

1. Phacoemulsification

Zaidi et al[46] reported 1 case of endophthalmitis (0.1%) in a 1000 patient training hospital phacoemulsification audit.This is in keeping with the findings of 0.55 cases per 1000 cataract operations reported by Kelly et al[115] in 2005 in a study at a United Kingdom district general hospital and is also in keeping with the 1 case (0.2%) reported by Riley et al[47] in a New Zealand training hospital study.

Minassian et al [31]reported in 2001 on a landmark study comparing extracapsular cataract to small incision phacoemulsification surgery.He reported 3 cases(1%) of endophthalmitis in the phaco group and 1 case(0.4%)in the ECCE group.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.The authors wanted to define the outcomes and risks of cataract surgery in this more modern era, in which extracapsular cataract surgery and phacoemulsification were used.The proportion with endophthalmitis ranged from 0.74% in a phaco study , between 0% and 1.9% in ECCE studies.

2. MSICS

Hennig et al[59] reported no cases of bacterial endophthalmitis in a study of 500 cases of MSICS in Nepal.

Ventkatesh et al[60] reported no cases of bacterial endophthalmitis , in a study of 593 MSICS patients in India. They did report on a single case of hypopyon uveitis.

The endophthalmitis risk in MSICS seems to be in the range expected in patients undergoing phacoemulsification,but further data on this is needed.

3. Extracapsular Cataract Surgery

Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens at an African training hospital reported zero endophthalmitis cases in a 461 eyes study.Alhassan et al[116] reported in 2000 on a extracapsular cataract surgery training workshop for consultant ophthalmologists in Nigeria.They reported 1 case of bacterial endophthalmitis(0.6%).This is similar to the incidence reported in Sierra Leone[97] of 0.47% in a much larger series.

c. Wound dehiscence and leakage

1. Phacoemulsification

Zaidi et al[46] reported 11 cases of wound leaks (11%) in a 1000 patient training hospital phacoemulsification audit.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.The proportion with wound gape varied in the phaco group between 0% to 1.6% , and in the ECCE group between 0% to 3%.

2. MSICS

No wound leaks were reported by Hennig et al[59] and Venkatesh et al.[60]

d. Hyphaema

Venkatesh et al[60] reported 1(0.2%) case of postoperative hyphaema in 593 patients in an expert-based MSICS study.

Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens at an African training hospital reported 9 hyphaemas in a 461 eyes study.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.The proportion with intraoperative or early postoperative

hyphaema in the phaco group varied from 0.1% to 1.5% , and in the ECCE group from 0% to 4%.

e. Postoperative uveitis

1. Phacoemulsification

Zaidi et al[46] reported 11 cases of persistent postoperative uveitis(11%) in a 1000 patient training hospital phacoemulsification audit.

2. MSICS

Venkatesh et al[60] reported that 67 eyes had 75 (12.6%) intraoperative complications in 593 patients in an expert based MSICS study.The authors used the OCTET grading system to categorise complications into 3 grades of severity. Uveitis was diagnosed in 25 (5.9%) eyes.A single case(0.2%) of hypopyon uveitis was diagnosed and managed with topical steroids and subconjunctival antibiotics.

3. Intracapsular Cataract Surgery

In an ICCE study with anterior chamber intraocular lens implantation in rural black patients,Cook et al[67] noted that 33% still had persistent uveitis at 3 months notwithstanding the steroid treatment offered.

4. Extracapsular Cataract Surgery

a. Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens at an African training hospital reported 15 cases of postoperative uveitis in a 461 eye study.

b. Alhassan et al[116] reported in 2000 on a extracapsular cataract surgery training workshop for consultant ophthalmologists in Nigeria.In this study of 175 eyes postoperative uveitis was not documented,but 8% of patients had residual cortex.

f. Malposition of an intraocular lens

1. Phacoemulsification

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.Malposition or dislocation of an intraocular lens occurred in 0.4 to 4.9% of the PHACO studies and for ECCE from 0% to 7.7%.

2. MSICS

Hennig et al[59] in an expert based study reported a single case of intraocular malposition out of 500 eyes.

Venkatesh et al[60] reported 3 (0.5%) cases of intraocular lens malposition in 593 patients in an expert based MSICS study

3. Intracapsular Cataract Surgery

Snelligen et al[117] noted that 0.7% of their anterior chamber intraocular lenses needed repositioning and 0.3% of the intraocular lenses were explanted .[117] In the Lahan study there were no cases of dislocated intraocular lenses.[118]

In the review by Powe et al malposition or dislocation of the intraocular lens varied from 0.4 to 4.9% in a variety of different surgical techniques.

g. Retained lens cortex

Olson et al [88] in 1998 reported on a study comparing the first 50 resident cases of phacoemulsification with the last 50 cases of their training.They reported a 1% incidence of residual lens cortex in the visual cortex.

3. LATE POSTOPERATIVE COMPLICATIONS

a. Posterior Capsule Opacification

1. Phacoemulsification

Zaidi et al[46] reported 8 cases (0.8%)of postoperative posterior capsule opacity in a 1000 patient training hospital phacoemulsification audit ,however the follow-up

was inadequate as it only extended to 9 months.This would result in under-reporting of the long-term rate.

Minassian et al [31]reported in 2001 that posterior capsule opacification occurs in 20 and 29% of phaco and ECCE eyes respectively.The intraocular lenses used in both groups were different,and are an independent variable for posterior capsule opacification.

Powe et al[28] reported that the proportion with posterior capsule opacification in the phaco group varied between 0.67% and 38.5%,and in the ECCE group from 0.8% to 31.0%.These findings were reported in a setting of follow-up from 60 to 1825 days.

2. MSICS

Hennig et al[59] reported 3 eyes (2.2%) had posterior capsule opacification in a total of 134 eyes ,out of 150 eyes requested to follow-up at 1 year. This study had initially 500 eyes that were operated on.It would have been useful to have a large series at the 1 year visit.

Ruit et al[38] reported in 2006 on the 6 month outcomes of a randomised control trial comparing phacoemulsification to sutureless manual small incision cataract surgery.At six months 24 of 46 eyes (56.5%)in the MSICS group had no posterior capsular opacification versus 41 of 48 patients in the phaco group(85.4%).The patients who did have posterior capsule opacification , had a lower grade in the phaco group than the MSICS group. This is most probably related to the truncated edge silicone lens used in the phaco group.

3. Intracapsular Cataract Surgery

Posterior capsule opacification does not occur in ICCE surgery since the capsule has been removed.

4. Extracapsular Cataract Surgery

Prajna[64] et al in a large study with ECCE and PMMA intraocular lenses at Aravind Eye Hospital found that at 1 year 82% of patients has some form of posterior capsule opacification.Another 8.6% had central posterior capsule

opacification which had the potential to threaten vision later. At 4 years 13.5% of patients had clinically significant posterior capsule opacification.[65]

b. Corneal oedema and Bullous keratopathy

1. Phacoemulsification

Zaidi et al[46] reported 7 cases (0.7%)of persistent postoperative corneal oedema in a 1000 patient training hospital phacoemulsification audit.

Powe et al[28] reported that the proportion of eyes with bullous keratopathy in the PHACO studies varied from 0 % to 3.0% , and in the ECCE group from 0% to 6%.

2. MSICS

Venkatesh et al[60] reported 33(5.5%) intraoperative cases of transient corneal oedema at day 2 in 593 patients in an expert based MSICS study.The authors of this study did not report on the presence of corneal oedema at the day 40 visit. Hennig et al[59] in another expert based study reported 2 cases (0.4%) of corneal oedema at 6 weeks.No data regarding the incidence of corneal oedema or bullous keratopathy was noted at 1 year.

Gogate et al[27] reported in 2005 on the outcomes of a randomised control trial comparing phacoemulsification to manual small incision cataract surgery.They reported no cases of corneal oedema in both groups at the six week follow-up.

Kothari et al[17] reported in 2003 on an Indian training hospital study of 2095 eyes which had undergone predominantly MSICS (1455 eyes).Vitreous loss occurred in 160 eyes , and corneal decompensation occurred in 7.1%(10 eyes) of the vitreous loss group.

Gogate et al.[27] in a study comparing PHACO to MSICS , noted that there was no statistical difference in endothelial loss between the groups.Mean induced cell loss at 6 weeks in the PHACO group was 5.41% and 4.21% in the MSICS group. However in the same study 9% of the phaco group and 4.5% of the MSICS group had first day corneal oedema,which resolved in all cases.

3. Intracapsular Cataract Surgery

Corneal decompensation has been reported as occurring in 0.2% of patients undergoing ICCE with intraocular lens.[117] Snellingen et al [117] had reported that in eyes undergoing ICCE with and without intraocular lenses significant endothelial cell loss occurs.At 2 years they noted that both groups had a total cell loss of 45.6% and 10% of eyes had a cell density of less than 1500 cells/mm^2. The Oxford Cataract Treatment and Evaluation team[119] also reported that continuing cell loss occurred in both aphakic eyes and pseudophakic eyes up to 5 years after surgery.In a study by Cheng et al this led to corneal decompensation in 8 out of 330 eyes.Hennig et al in the Lahan Study found that 1% of the pseudophakic group had corneal oedema at the last follow-up.Powe et al[28] in a review of all types of cataract surgery noted that corneal decompensation occurred in 0% to 0.6% of eyes.

4. Extracapsular Cataract Surgery

Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens at an African training hospital reported zero cases of corneal decompensation in a 461 eyes study.Alhassan et al[116] reported in 2000 on an extracapsular cataract surgery training workshop for consultant ophthalmologists in Nigeria.At the earliest follow-up visit,they noted a significant incidence of postoperative corneal oedema/striate keratopathy(44.6%), whether this resulted in corneal decompensation is unknown as the follow-up in most cases was too short.

George et al[37] in a study comparing ECCE to MSICS,noted that there was no statistical difference in endothelial loss between the groups.Mean induced cell loss at 6 weeks in the ECCE group was 4.72%(n=52,SD13.07) and 4.21% in the MSICS group.

c. Glaucoma

1. Phacoemulsification

Zaidi et al[46] reported 3 cases (0.3%)of persistent postoperative raised intraocular pressure in a 1000 patient training hospital phacoemulsification audit.

Powe et al[28] in 1994 published a meta-analysis of 90 studies published between 1979 and 1991.The pooled result for postoperative angle closure glaucoma in phaco was 1.0% in the phaco group and 0.1% in the ECCE group.This difference had no statistical significance. Postoperative open angle glaucoma , was found to occur in 0% to 8.13% of phaco eyes and in 0% to 19.7% of the ECCE group.

2. MSICS

No cases were reported by Hennig and Venkatesh.[59;60]

3. Intracapsular Cataract Surgery

Cook et al[67] reported that in a group of black patients having ICCE and anterior chamber intraocular lens 5% had a raised intraocular pressure at 6 months.This may be due to the observed increased inflammatory reaction that has been noted in these patients.Snellingen et al[117] in their study in India noted 0.4% of ICCE with anterior chamber intraocular lens cases developed secondary glaucoma. Hennig et al[70] in the "Lahan study" diagnosed secondary glaucoma in 0.7% of the pseudophakic group and 0.3% of the aphakic group at more than 1 year of follow-up.This should be compared to Powe et als[28] review of 90 studies of all types of cataract surgery where secondary glaucoma was noted in 0% to 0.6% of eyes.

d. Retinal Detachment

1. Phacoemulsification

Minassian et al [31]reported in 2001 on a landmark study comparing extracapsular cataract to small incision phacoemulsification surgery.They reported 2 retinal detachments(1%) in the phaco group and zero in the ECCE group.

Powe et al[28] reported in the phaco studies group the proportion with retinal detachment varied from 0% to 1.7% , and in the ECCE group it varied from 0% to 2%.

2. MSICS

No cases of retinal detachment were reported by Hennig et al or Venkatesh et al .[59;60] This may be a feature of a shorter follow-up period.

3. Intracapsular Cataract Surgery

The incidence of retinal detachment following intracapsular cataract surgery has been reported as being nil in black patients in two early studies.[120;121] In the South Asia Cataract Management Study[117] the overall cumulative rate of retinal detachment was 0.6% . It was higher in the aphakic group at 0.8%.These findings are similar to the 0.7% in the ACIOL group and the 0.8% in the aphakic group at 1 year in the Lahan study.[70]However Prajna et al[64] at Aravind Eye Hospital found at 1 year 0.4% of ICCE patients developed retinal detachment.

4. Extracapsular Cataract Surgery

a. Prajna et al[64] at Aravind Eye Hospital found at 1 years 0.2% of ECCE with posterior chamber intraocular lens patients developed retinal detachment.

b. Yorston and Foster[72] in a retrospective review of extracapsular cataract surgery with posterior chamber intraocular lens at an African training hospital reported zero new retinal detachments in a 461 eyes study.

e. Intraocular lens related problems.

Visually significant opacification of intraocular lenses have been reported by several authors.[122] This may be due to calcification of the material related to manufacturing problems.

(G)SUMMARY

Cataracts account for approximately 50% of blindness worldwide.Cataract surgery techniques have evolved with time to meet this demand.

Data regarding blindness in South Africa is well known with over 160000 blind from this disease,however studies regarding both outcomes and complications of cataract surgery in South African training hospitals is limited,with the last study published in 2001 reviewing extracapsular cataract surgery.[123] Newer techniques of phacoemulsification and manual small incision cataract surgery have superseded conventional extracapsular cataract surgery.

Phacoemulsification visual outcomes have been reported in training environments with postoperative best corrected visual acuity of 6/12 or better in 88-93% of patients.[47;124] MSICS expert studies have reported best corrected visual acuities of 6/18 or better in 94.4% to 98.4% of eyes.[27;59;60] ECCE studies in training environments have reported best corrected visual acuities of 6/18 or better in 94.3% of eyes[72],and best corrected visual acuities of 6/12 or better in 89% of cases.[45]

Studies of older techniques like ICCE , have reported visual acuities of 6/18 or better in 82% to 93.2% of eyes.[22;68;70;117;118] This had been in some settings with the disadvantage of aphakic glasses and a longer visual recovery to best corrected visual acuity.

Comparisons of studies are difficult due to the lack of standardised follow-ups,visual acuity benchmarks,complication grading,and variations of surgical techniques.

Posterior capsule rupture and vitreous loss rates are regarded as a serious intraoperative complications of cataract surgery.It is associated with poorer visual outcomes.[17]I will discuss them here as they are also associated with some of the postoperative complication discussed earlier.They also provide an indication of overall incidence of complications.In an early resident study Cotlier and Rose reported a 14.2% of vitreous loss during phacoemulsification in beginner residents.[85] Fortunately this has improved with newer techniques and equipment. Zaidi et al[124] reported a vitreous loss rate of 1.1% in PHACO and Riley et al[47] reported a 4.9%

posterior capsule rupture rate in PHACO.

MSICS expert studies have reported vitreous loss rates of 0% , 0.2% and 0.7%.[27;59;60]Kothari et al[17] in an Indian training hospital study reported vitreous loss of 8.1% in a MSICS group.

In ICCE studies Snellingen et al[117] reported a vitreous loss rate of 11.2% and Cook et al[67] reported a 16% vitreous loss rate.These are higher than those quoted in both the MSICS and PHACO groups.Finally ECCE studies have reported vitreous loss rates of 1.7% by Claoue et al[92] to 9% in a resident based study by Browning and Cobo.[45]Yorston and Foster[72] documented a vitreous loss rate in 4.6% of eyes in a African training hospital.

These findings provide the basis for questions regarding the outcomes in the population served by a South Africa training hospital which is addressed in the following section.

(4)AUDIT OF CATARACT SURGERY AT GROOTE SCHUUR HOSPITAL

(A) INTRODUCTION

Cataract is the leading cause of blindness in Southern Africa, responsible for an estimated 50% of blindness (0,50% of the total population, 5 000 per million population).

Groote Schuur hospital is a large training hospital within an urban environment in Cape Town ,South Africa.Most of the cataract surgery done at Groote Schuur Hospital is done on cataract project lists.Cataract project lists are cataract surgery lists where a medical officer performs the local anaesthesia and monitors the patient. Patients requiring general anaesthesia or having medical problems which place them at high risk are performed on other theatre lists.Cataract surgery constitutes a significant proportion of our surgical training and at Groote Schuur we do not have an audit system in place.

1. Justification

The justification for carrying out this research is to report on the visual outcomes and complications of cataract surgery done at Groote Schuur hospital ,a large training hospital.No South African data regarding phacoemulsification or MSICS visual outcomes or complications is to my knowledge available.This study provides data regarding a local teaching hospital, both as a benchmark and for future improvement.

2. Objective

The Research question was :

In patients undergoing cataract surgery at Groote Schuur Hospital, what are the outcomes in terms of postoperative visual acuity, postoperative refraction, intra and postoperative complications.

(B)MATERIAL AND METHODS

Groote Schuur hospital contains a large ophthalmic department, which is affiliated to the Faculty of Health Sciences of the University of Cape Town. It is one of two tertiary public ophthalmic units in Cape Town.It is staffed with 5 full time consultant ophthalmic surgeons with a varying number of visiting consultant sub-specialists . It is a training hospital and thus has the following members of junior staff : one senior house officer and 7 registrars.It has two ophthalmology theatres , these primarily perform tertiary level services.Due to poor availability of cataract surgical services in both secondary and district hospitals,a significant number of low risk cataract surgery is also undertaken.These are booked onto dedicated cataract project lists. These lists are staffed by a medical officer who injects the local anaesthetic(predominantly subtenon's blocks are used) and a surgeon to perform the surgery.Patients who have indications for general anaesthetic,other severe medical problems or who need combined procedures are booked on alternative theatre lists. This service is provided free of charge with funding provided by Non Governmental Organisations as well as by the South African government.

Cataract surgery patients undergo a standard preoperative and postoperative evaluation.Preoperative assessment is usually undertaken by registrars with consultant input.A full ophthalmic and medical history with the relevant examinations are undertaken.These include slit lamp biomicroscopy , dilated fundoscopy with peripheral examination,Goldmann intraocular pressure measurement,autokeratorefractometry(Hurvitz) and axial length measurements(Alcon ocuscan).

Cataract surgery on the dedicated project lists is undertaken using a variety of different techniques:

1)Phacoemulsification is the predominant technique used.The department is equipped with the latest venturi and peristaltic phacoemulsification systems.Both the Bausch and Lomb Millineum surgical systems and the Alcon Infinity systems(with

torsional ultrasound) are used.Techniques vary as described in the first part of my dissertation.At Groote Schuur the predominant technique involves making a clear corneal incision of 3.2mm with the foldable acrylic intraocular lens injected via the same wound.On some occasions due to the limited availability of foldable intraocular lenses,a polymethylacrylate lens of 5.5 mm diameter is placed after the wound is enlarged. (FH 105 , Fred Hollows , Nepal)

2)Manual Small Incision Cataract Surgery is the second most frequent technique used. The technique is as described in the first section of my thesis.
A polymethylacrylate intraocular lens is placed in the bag or the ciliary sulcus.
A sutureless approach is not used,with the majority of cases having a single nylon suture.
3) Intracapsular cataract surgery (with or without kelman type anterior chamber intraocular lens) is surgical choice in the setting of an unstable lens due to zonular problems.This is commonly used in the eyes that have sustained trauma in the past.
4) Extracapsular cataract extraction with intraocular lens is also performed by surgeons in our department.A polymethylacrylate intraocular lens is placed in the bag or the ciliary sulcus.The indications may vary,but it is a technique used by junior trainees as well as in cases with poor corneal transparency e.g. scarring.

Surgical prophylaxis for endophthalmitis includes intracameral cefuroxime with a betadine preoperative wash.Postoperatively all patients receive topical steroid /antibiotic combination(dexamethasone and chloramphenicol) and are reviewed in the first week and thereafter several weeks later.Subsequent visits vary depending on the clinical problems encountered.

1. STUDY DESIGN

A retrospective observational study design was chosen by the author,as it would provide useable data more quicker as well as to provide the basis for a future prospective study.

2. SAMPLING STRATEGY

The study population was identified from the operating theatre cataract project lists for the period 1 Jan 2006 till the 31 Dec 2006.The medical records of each patient

were obtained from the medical records department.Patients were excluded if their medical records indicated that they did not have the surgery on the listed day,this occurred if the patient did not arrive for surgery or was medically unwell.Patients were also excluded if surgery was undertaken on non cataract project lists,since cataract project lists had standardised records which made file review easier.The surgical details were obtained from the cataract surgery preoperative assessment form, operative notes,and postoperative notes.

3. SAMPLE SIZE

Nine hundred and eight eyes were identified (All cases listed on the cataract project list 2006.) Of these sixty two eyes were excluded since they had not undergone surgery on the specified days.Thus the sample size was was nine hundred and eighteen eyes.

4. MEASUREMENT (see appendix II)

Data on each patient was collected from the clinical records as follows :

1. **Preoperative data –**
    - Name
    - Date of Birth
    - Age
    - Gender
    - Ocular and Systemic Comorbidity: Diabetes, Diabetic Retinopathy, Macular Degeneration, Glaucoma, Pseudoexfoliation, Ocular Trauma, Central Retinal vein occlusion, Other.
    - Domicile (Cape Town Metropole, outside Cape Town Metropole)
    - Preoperative Snellen visual acuity right eye –uncorrected
    - Preoperative Snellen visual acuity left eye-uncorrected
    - Preoperative Keratometry readings right eye
    - Calculated intraocular lens power for emmetropia Right(using A- constant of implanted IOL)
    - Preoperative Keratometry readings left eye
    - Calculated intraocular power for emmetropia –left(using A-constant of implanted IOL)
    - Biometrist : Pat / Farieda / Unknown / Doctor

2. **Surgical data –**

- Date of surgery
- Surgeon
- Capacity of Surgeon
- Supervisor
- Type of surgery

- Surgical wound site in phaco/ecce :superior ,temporal , in between
- Operated eye :Right or left eye
- Intraocular lens type-foldable or polymethylacrylate
- Intraocular lens placement site –anterior chamber ,ciliary sulcus ,capsule bag
- Intraocular lens power in dioptres
- Intraocular lens manufacturer specific A-Constant
- Intraoperative complications

3. **Postoperative visit Day 1 –10**

- Corneal oedema on slit lamp examination
- Uncorrected snellen visual acuity

4. **Postoperative Last Visit: week 1-10**

- Follow-up duration
- Uncorrected Snellen visual acuity
- Best corrected Snellen visual acuity
- Keratometry readings
- Postoperative Refraction (Sphere / Cylinder/Axis and SE)
- Post-operative complications (endophthalmitis, posterior capsule opacification requiring YAG capsulotomy, other).
- Cause of Poor outcome (VA < 6/18):
    - 1)Intraoperative complication
    - 2)Postoperative complication
    - 3)Comorbidity
    - 4)Uncorrected refractive error

Other Data

- Preoperative Keratometry readings illegible
- Biometry illegible
- Postoperative Keratometry –Readings/Autorefraction illegible
- Refraction done beyond last visit
- Only eye operated on(in 2006)
- First eye / second eye undergoing surgery (in 2006)
- Other eye operated on non cataract project list (in 2006)
- Pt did not present for first visit
- Pt did not present for last visit

The primary outcome measures for this study were –

1. Uncorrected Snellen visual acuity at last visit

The secondary outcome measures for this study were –

1. Uncorrected Snellen visual acuity on day 1-10
2. Uncorrected Snellen visual acuity at week 1-10.
3. Best corrected Snellen visual acuity at week 1-10.
4. Refraction at postoperative visit when performed
5. Posterior capsule rupture during surgery.
6. Other intra-operative complications.
7. Corneal oedema on day 1.
8. Endophthalmitis proportion till the last follow-up

9. Posterior capsule opacification requiring YAG capsulotomy during week 1-10 follow-up period.
10. Other post-operative complications.
11. Incidence of secondary surgical procedures necessitated by complications

5. PILOT STUDY

The study was piloted with the first group of 50 patient records, and the protocol did not need alteration on the basis of this review.

6. ANALYSIS

- DATA ENTRY

All files were reviewed by the author, an ophthalmology registrar.

A research assistant coded and entered the data on a weekly basis.

Data entry was be done using a custom designed template in Microsoft Access 2002 to minimize data entry errors.

- DATA ANALYSIS

Data was analysed using the statistical programme Stata Version 10.0 as well as with the statistical features available in Microsoft Excel 2000.

Variables were described using means, medians and proportions, as appropriate.The student t test (for means) was used for bivariate comparisons,Medians were compared using the Wilcoxon sum rank test , and Proportions were compared using the Chi-square or Fisher's exact test.The main analysis will focus on describing the differences between the two predominant surgeries,namely phacoemulsification and MSICS with respect to the primary and secondary outcome measures.A p-value less than 0.05 denoted statistical significance.

7. ETHICAL ISSUES

Ethical approval was obtained from the Research Ethics Committee of the University of Cape Town Faculty of Health Sciences.All personal identifying data

was removed from our database.Approval to access records was also obtained from the Groote Schuur Hospital management

(C)RESULTS

1. DEMOGRAPHICS

A total of 918 eyes underwent cataract surgery on the cataract surgery project lists in 2006.Of these 736 eyes(80.17%) underwent phacoemulsification,171((18.63%) eyes underwent manual small incision cataract surgery,8(0.87%) eyes underwent conventional extracapsular surgery,3(0.33%) eyes underwent intracapsular cataract surgery , and in 2 eyes the surgery was not classified.The later three groups due to their small size will not be discussed in any further detail.(Table 2)

The mean age of the respective groups was 67.4 years for the phacoemulsification group,69.9 years in the Manual small incision cataract surgery group.The older age in the manual small incision group was statistically significant ($p<0.0078$).Data on patients ethnicity was not captured.This is presented in table 3.

Females predominated in both the phacoemulsification group as well as in the MSICS group , with 66.21% and 65.68% in these groups respectively.(Table 4)

Geographic distribution of patients indicated that 95.19% of the eyes in the phacoemulsification group and 98.18% of those in the MSICS group were from the cape metropolitan area .(Table 5)

Table 2 Cataract Surgery Groups

PHACO-number	%	MSICS-number	%	ECCE-number	%	ICCE-number	%	Other-number
736	80.17	171	18.63	8	0.87	3	0.33	2

Table 3 Patient Characteristics

Age	PHACO-years		MSICS-years		p-value if applicable

Mean age	67.4		69.9		0.0078
Median age	68		70		0.00216
Range	20-96		46-93		

Table 4 Gender Distribution of operated eyes

Gender	PHACO-number	%	MSICS-number	%	p-value if applicable
Male	246	33.79	58	34.32	
Female	482	66.21	111	65.68	
	728	100	169	100.00	p=0.928

Table 5 Geographic distribution of operated eyes

Biometrist	PHACO-number	%	MSICS-number	%	p-value if applicable
Metropolitan area	693	95.19	162	98.18	
Outside metropolitan area	35	4.81	3	1.82	
	728	100	165	100	p=0.091

2. <u>PREOPERATIVE VISUAL ACUITY AND OCULAR CHARACTERISTICS</u>

Uncorrected preoperative visual acuity was 6/18 or better in 109 eyes(14.97%) in the phacoemulsification group and in 2 eyes(1.18%) in the MSICS group. Uncorrected visual acuity of less than 6/60 was present in 445 eyes(61.13%) of the phacoemulsification group and in 163 eyes(96.45%) of the MSICS group. These differences in visual acuity between the groups was statistically significant ($p<0.0001$).The preoperative visual acuity is presented in Table 6

The distribution between right and left operated eyes in both groups,is presented in table 6. There was no statistical significant difference between the groups.

All biometry was performed by one of two technicians, with no biometries recorded as having been performed by a doctor.This data is presented in Table 7.

Prevalent medical and ocular co-morbidities are presented in Table 8. Diabetes (without diabetic retinopathy) was present in 159 patients(21.65) in the phacoemulsification group and in 30 patients(17.54%) in the MSICS group. Diabetes (with diabetic retinopathy) was present in 108 eyes(14.67%) in the phaco group and in 16 eyes(9.36%) of the MSICS group.

Preoperative keratometry showed that astigmatism of 1.99dioptres or less was present in 658 eyes (90.14%)in the phaco group and in 148 eyes(86.55%) in the MSICS group.The median preoperative astigmatism in both groups was 0.75 dioptres.This data is presented in Table 9.

Table 6 Uncorrected Preoperative visual acuity in the operated eye and Right versus left distribution of eyes.

Visual acuity category	PHACO-number	%	MSICS-number	%	p-value if applicable
6/6 to 6/18	109	14.97	2	1.18	
6/24 to 6/24	174	23.9	4	2.37	
5/60 to NPL	445	61.13	163	96.45	
	728	100	169	100	P<0.0001
Right versus Left	PHACO-number	%	MSICS-number	%	p-value if applicable
Right	355	48.23	83	48.54	
Left	381	51.77	88	51.46	
	736	100	171	100	p=1.0

Table 7 Biometrist data

Biometrist	PHACO-	%	MSICS-	%	p-value if

	number		number		applicable
Technician 1	355	48.23	83	48.54	
Technician 2	381	51.77	88	51.46	
	736	100	171	100	p=1.0

Table 8 Medical and Ocular Comorbidities

Comorbidity	PHACO-number	%	MSICS-number	%	p-value if applicable
Diabetes without diabetic retinopathy	159	21.6	30	17.54	0.252
Diabetes with diabetic retinopathy	108	14.67	16	9.36	0.083
Age related macular degeneration	23	3.13	0	0	
Glaucoma	38	5.16	3	1.75	
Pseudoexfoliation syndrome	1	0.14	0	0	
Ocular Trauma	0	0	0	0	
Central retinal vein occlusion	2	0.27	0	0	

Table 9 Preoperative keratometric cylindrical astigmatism

Astigmatism categories	PHACO-number	%	MSICS-number	%	p-value if applicable
0 dioptre to 0.99 dioptre	425	58.21	88	51.46	
1 dioptre to 1.99 dioptre	233	31.92	60	35.09	
2 dioptre to 2.99 dioptre	44	6.03	12	7.02	

Greater than 3.0 dioptre	28	3.84	11	6.43	
		100.00		100	p=0.247

3. SURGICAL DATA

The principle surgeons were predominantly registrars with 546 eyes (74.18%) in the phacoemulsification group and 95 eyes (55.56%) in the MSICS group performed by registrars respectively.This was statistically significant (p<0.0001). The surgery was not supervised by a consultant in 525 eyes(95.98%) in the phacoemulsification group and in 76 eyes(63.87%) in the MSICS group.This difference in supervision was statistically significant(p<0.0001).The majority of surgeries had some degree of trainee involvement,this occurred in 628 eyes(85.33%) in the phacoemulsification group and in 138 eyes(80.7%) in the MSICS group.This data is presented in Table 10.

Foldable intraocular lenses were placed in 600 eyes(81.63%) in the phacoemulsification group and in 5 eyes(2.94%) in the MSICS groups (p<0.0001).In the phacoemulsification group 9 eyes(1.22%) were left aphakic and 2 eyes(1.18%) in the MSICS group were left aphakic.The mean intraocular lens power was 20.8 dioptres in the phacoemulsification group(0 to 30 dioptres) and 21.1 dioptres in the MSICS group(Range 4 to 29 dioptres).This data is presented in Table 11.

Temporal wound construction was performed in 391 (53.13%) of the phacoemulsification eyes and superior wound construction occurred in 169 eyes(98.83%) of the MSICS eyes.This data is presented in Table 12.

Table 10 Surgeon and supervision

Category of Principle Surgeon	PHACO-number	%	MSICS-number	%	p-value if applicable

Registrar	546	74.18	95	55.56	
Consultant	189	25.68	52	30.41	
Senior house officer	1	0.14	24	14.04	
	736	100	171	100	p<0.0001
Level of Supervision	PHACO-number	%	MSICS-number	%	p-value if applicable
Unsupervised	525	95.98	76	63.87	
Consultant	22	4.02	41	34.45	
Registrar supervising	0		2	1.68	
	547	100	119	100	P<0.0001
Training surgery	PHACO-number	%	MSICS-number	%	p-value if applicable
Yes	628	85.33	138	80.7	
No	108	14.67	33	19.3	
	736	100	171	100	P=0.159

Table 11 Intraocular lens details

Intraocular lens type	PHACO-number	%	MSICS-number	%	p-value if applicable
Foldable acrylic lens	601	81.66	5	2.92	
Polymethylacrylate lens	122	16.58	162	94.74	
No lens –left aphakic	9	1.22	2	1.17	
Unknown lens	4	0.54	2	1.17	
	736	100	171	100	P<0.0001

Table 12 Main surgical wound

	PHACO-number	%	MSICS-number	%	p-value if applicable
Superior	147	19.97	169	98.83	
Temporal	391	53.13	0	0	
In Between superior and temporal	169	22.96	1	0.58	
Unknown	29	3.94	1	0.58	
	736	100	171	100	P<0.0001

4. INTRAOPERATIVE COMPLICATIONS

Intraoperative complications occurred in 54 eyes(7.34%) in the phacoemulsification group and in 22 eyes(12.87%) in the MSICS group.This difference , with fewer intraoperative complications in the phacoemulsification group was statistically significant p=0.031 See table 13.

Posterior capsule rupture without vitreous loss occurred in 5 eyes of 54 eyes(9.26%) with intraoperative complications in the phacoemulsification group and in 4 eyes of 22 eyes(18.18%) in the MSICS group.Posterior capsule rupture with vitreous loss occurred in 22 eyes of 54 eyes(40.74%) with intraoperative complications in the phacoemulsification group and in 9 eyes of 22 eyes(40.91%) in the MSICS group.Dropped nuclear fragments occurred in 2 eyes of the phaco group and represented 3.7% of intraoperative complications.

The posterior capsule rupture rate in the phaco group was 3.94%(29 eyes of 736 eyes) and in the MSICS group 7.6%(13 eyes of 171 eyes).The difference between the groups , was statistically significant(p=0.066).Vitreous loss in the phacoemulsification group occurred in 24 eyes out of 736 eyes(3.2%) , and in 9 eyes out of 171 eyes (5.2%)in the MSICS group.

Other unspecified complications occurred in 25 eyes of 54 eyes(46.3%) with intraoperative complications in the phacoemulsification group and in 9 eyes of 22 eyes (40.91%) in the MSICS group.

Table 13 Intraoperative complications

Complications	PHACO-number	% (54 eyes)	MSICS-number	%(22 eyes)	p-value if applicable
Posterior capsule rupture without vitreous loss	5	9.26%	4	18.18	
Posterior capsule rupture with vitreous loss	22	40.74%	9	40.91	
Dropped nuclear fragments	2	3.7%	0	0	
Suprachoroidal haemorrhage	0	0	0	0	
Other unspecified complications	25	46.3%	9	40.91	
					0.677

5. POSTOPERATIVE OUTCOMES FOR FIRST VISIT

Postoperative follow-up on the first visit occurred a mean of 3.9 days after the surgery in the phacoemulsification group and a mean of 4.03 days after MSICS surgery.Of note at the first follow-up visit were the 44 eyes in the phacoemulsification group and the 34 eyes in the MSICS groups with no recorded visual acuities. (Table 14)

Uncorrected visual acuity was 6/18 or better in 411 eyes of 683 eyes(60.18%) (with recorded visual acuities) attending the first visit in the phacoemulsification group , and in 52 eyes of 135 eyes (37.78%)(with recorded visual acuities)in the MSICS group.Uncorrected visual acuity was 5/60 or less in 123 eyes of 683 eyes(18.01%) (with recorded visual acuities) attending the first visit in the phacoemulsification group , and in 39 eyes of 135 eyes (28.89%)(with recorded visual acuities)in the MSICS group.These differences in visual outcomes between the groups were statistically significant (p<0.0001).(See Table 15)

Corneal oedema at the first visit was noted in 273 eyes(38.54%) in the phacoemulsification group and in 92 eyes (55.42%) in the MSICS group. Unspecified corneal clarity was noted in 134 eyes in the phaco group and in 33 eye in the MSICS group.

Table 14 First Visit Subject data

Days from Surgery	PHACO-days	%	MSICS-days	%	p-value if applicable
Mean	3.9		4.04		-
Median	1		1		-
Interquartile range	1 to 2		1 to 2		-

Table 15 Uncorrected visual acuity at the first visit

Visual Acuity Category	PHACO-number	%	MSICS-number	%	p-value if applicable
6/6 to 6/18	411	60.18	51	37.78	
6/24 to 6/24	149	21.82	45	33.33	
5/60 to NPL	123	18.01	39	28.89	
	683	100.00	135	100	P<0.0001

6. POSTOPERATIVE OUTCOMES FOR THE FINAL VISIT(WEEK 1-10)

Postoperative follow-up on the last visit occurred a mean of 40.19 days after the surgery in the phacoemulsification group and a mean of 45.1 days after MSICS surgery.Of note at the last follow-up visit were the 385 eyes in the phacoemulsification group and the 105 eyes in the MSICS groups with no recorded best corrected visual acuities.This was out a total of 838 eyes who attended the last visit,of whom 678 were in the phaco group and 151 were in the MSICS group.Uncorrected visual acuities were not recorded in 5 eyes in the phaco group and 2 eyes in the MSICS group.(Table 16)

Uncorrected visual acuity was 6/18 or better in 498 eyes of 672 (73.56%) (with recorded visual acuities) attending the last visit in the phacoemulsification group ,and in 98 eyes of 149 (65.77%)(with recorded visual acuities)in the MSICS group.Uncorrected visual acuity was 5/60 or less in 56 eyes of 683 eyes(8.27%) (with recorded visual acuities) attending the first visit in the phacoemulsification group,and in 19 eyes of 149 eyes (12.75%)(with recorded visual acuities)in the MSICS group(p=0.103).(Table 17a)

Uncorrected visual acuity was 6/12 or better in 354 of 672 eyes(52.29%) attending the last visit in the phacoemulsification group , and in 50 eyes of 149 (33.56%)in the MSICS group.This difference was statistically significant (p<0.0001).

Best corrected visual acuity was 6/18 or better in 280 of 294 eyes (95.24%) (with recorded visual acuities) attending the last visit in the phacoemulsification group , and in 41 of 42 eyes (97.62%)(with recorded visual acuities)in the MSICS group.Best corrected visual acuity was 5/60 or less in 4 eyes of 294 eyes(1.36%) (with recorded visual acuities) attending the first visit in the phacoemulsification group,and in 0 eyes of 42 eyes (with recorded visual acuities)in the MSICS group.These differences were not statistically significant (p=1.0).(Table 17b)

Best corrected visual acuity was 6/12 or better in 258 eyes of 294 eyes(87.76%) attending the last visit in the phacoemulsification group and in 37 of 42

eyes(88.1%) in the MSICS group.This was not found to be statistically significant (p=1.0). (Table 18)

Best corrected visual acuity was 6/9 or better in 234 eyes of 294 eyes(79.59%) attending the last visit in the phacoemulsification group and in 27 of 42 eyes(64.29%) in the MSICS group.This difference of better outcome in the phacoemulsification group was noted to be statistically significant. (p=0.031)(Table 18)

Emmetropia as a refractive outcome was aimed for in 226 eyes in the phaco group and in 65 eyes in the MSICS group.The median spherical equivalent in the subgroup where emmetropia was aimed for was –0.625 dioptres(Interquartile range - 1.25 to –0.125) postoperatively , with no statistically significant difference between the groups.Overall median spherical equivalent was –0.75 dioptres.(Interquartile range –1.375 to 0 dioptres)

Postoperative keratometry showed that the astigmatism of 1.99dioptres or less was present in 434 eyes (80.82%)in the phaco group and in 52 eyes(54.73%) in the MSICS group.The median astigmatism in the phaco group was 1.0 dioptre and in the MSICS group 1.75 dioptres,this was found to be statistically significant(p <0.001). (Table 19)

Table 16 Last Visit Subject data

Days from Surgery	PHACO-days	%	MSICS-days	%	p-value if applicable
Mean	40.19		45.1		0.1032
Median	39		40		0.9919
Interquartile range	22 to 50		17 to 52		

Table 17a Uncorrected visual acuity at the last visit

Visual Acuity Category	PHACO-number	%	MSICS-number	%	p-value if applicable

6/6 to 6/18	498	73.56	98	65.77	
6/24 to 6/24	123	18.17	32	21.48	
5/60 to NPL	56	8.27	19	12.75	
	677	100	149	100	0.103

Table 17b Best corrected visual acuity at the last visit

Visual Acuity Category	PHACO-number	%	MSICS-number	%	p-value if applicable
6/6 to 6/18	280	95.24	41	97.62	
6/24 to 6/24	10	3.4	1	2.38	
5/60 to NPL	4	1.36	0	0	
	294	100	42	100.00	1.0

Table 18 Best corrected visual acuity 6/12 or better and Best corrected visual acuity 6/9 or better

Visual Acuity	PHACO-number	%	MSICS-number	%	p-value if applicable
6/12 or better	258	87.76	37	88.1	P=1.0
6/9 or better	234	79.59	27	64.29	P=0.031

Table 19 Postoperative keratometric cylindrical astigmatism at the last visit

Astigmatism categories	PHACO-number	%	MSICS-number	%	p-value if applicable
0 dioptre to 0.99 dioptre	226	42.09	17	17.89	
1 dioptre to 1.99 dioptre	208	38.73	35	36.84	

2 dioptre to 2.99 dioptre	63	11.73	24	25.26	
Greater than 3.0 dioptre	40	7.45	19	20	
	537	100		100	P<0.001

7. POSTOPERATIVE COMPLICATIONS

Postoperative complications occurred in 89 PHACO eyes (12.09%) and in 27 MSICS eyes (15.79%),this difference was not statistically significant(p=0.204).

Clinically apparent cystoid macular oedema was present in 8 eyes of 736 eyes(1.09%) in the phaco group,and in 1 out of 171 eyes in the MSIC group.

Bacterial endophthalmitis occurred in 5 eyes of 736 eyes (0.68%) in the phaco group and in zero eyes in the MSICS group.(Table 20) In the five patients who developed endophthalmitis,two patients were diabetic and one had glaucoma. The clear corneal surgical wound was temporal in 2 cases,superiorly in 1 case and in the balance superotemporal.Intraoperative complications occurred in 2 cases,one having posterior capsule rupture with vitreous loss and the other having an unspecifiedcomplication.Three cases had trainees involved,two were supervised and one case was unsupervised; and two cases had only consultants involved.Uncorrected visual outcomes were poor : one case had no perception of light,the other four cases had visual acuities between 6/24 and 6/60.
Best corrected visual acuity was noted in a single patient who improved from an uncorrected 6/24 to 6/9.

Table 20 Postoperative complications up till the last visit

Postoperative Complication	PHACO-number	%	MSICS-number	%	p-value if applicable
Clinically apparent cystoid macular oedema	8	1.09	1	0.58	1
Retinal Detachment	1	0.14	0	0	1

Corneal decompensation	2	0.27	0	0	1
Endophthalmitis	5	0.68	0	0	0.59
Other	33	4.48	20	11.7	0.001
Posterior capsule opacity	12	1.63	6	3.51	0.127
Diabetic macular oedema	36	4.89	2	1.17	0.032

8. SECONDARY SURGICAL PROCEDURES

The commonest secondary surgical procedures till the last visit included pan retinal photocoagulation (21 of 736 phaco eyes) and argon macular focal laser for macular oedema(19 of 736 phaco eyes).None of these procedures were performed in the MSICS group which is statistically significant.(This data is presented in Table 21)

Table 21 Secondary Surgical Procedures up till the last visit

Surgical Procedure	PHACO-Number	%	MSICS-Number	%	p-value where applicable
Displaced iol positioning	2	0.27	3	1.75	0.049
Displaced iol removal	0	0	0	0	
PPV for retinal detachment	1	0.14	0	0	1.0
PPV for lens fragment	3	0.41	1	0.58	
Intravitreal tap and antibiotics	5	0.68	0	0	
Evisceration	0	0	0	0	
Anterior chamber intraocular lens	2	0.27	0	0	
Sutured in intraocular lens	0	0	1	0.58	
Repair wound dehiscence	0	0	0	0	
Yttrium aluminium garnet laser capsulotomy	2	0.27	1	0.58	

Pan retinal photocoagulation	21	2.85	0	0	0.021
Argon macular laser	19	2.58	0	0	0.034
Yttrium aluminium garnet laser to vitreal strand	2	0.27	0	0	
Other procedures	6	0.82	3	1.75	0.382

9. CAUSES OF POOR VISUAL OUTCOME (Visual acuity<6/18)

This data will not be presented , as it was felt that the data may not be a true reflection of the sample , due to the subjective nature of assessing cause of poor outcome from the clinical record.

(D)DISCUSSION

A total of 918 eyes underwent surgery in this study . Phacoemulsification was performed in 80.17%,manual small incision cataract surgery was performed in 18.63%,extracapsular cataract surgery was performed in 0.87% , intracapsular cataract surgery was performed in 0.33% of cases.This distribution of cases by surgical technique is a manifestation of the unique South African teaching environment,where both third and first world environments are present, thus both techniques of the developing world and the developed world apply.In our setting brunescent or white cataracts would undergo MSICS in particular surgeons' hands, whereas other surgeons would opt to phacoemulsify the same cases. Thus the choice of technique is surgeon dependent.Typically junior trainees would be taught MSICS prior to the transition to phacoemulsification.

1. DEMOGRAPHICS

This retrospective study pertains to an urban population in a large South African city. Though this study did not collect data relating to the ethnicity of the population served,it is known to the author that this hospital serves all South Africans including those of Caucasian ,African ,Indian,mixed race and Cape Malay origin .

The mean ages of both the PHACO and MSICS group is younger than those reported by Zaidi et al [124]in the United Kingdom and by Riley et al[47] in New Zealand.However the mean ages of the both the phaco and MSICS groups is older than those published by Ruit el al[38] in Nepal.Thus the ages of our population are in keeping with these international studies.More than 50% female gender predominance was reported which was demonstrated in both groups.Zaidi et al reported a 62% female predominance in their study,similar reports have been made by Riley et al ,Hennig el al[59] and Ruit el al.This gender imbalance is most certainly due to the longer life expectancies in women.Geographic distribution , with a predominantly urban-based population in this study,has not been addressed in the aforementioned developed country studies,where the expectation is that the population within close proximity to the hospital will use its services.It is well known that medical services in South Africa are poorly spread with poor access to rural inhabitants,one would have expected a larger number of non-metropolitan inhabitants to have tried to

access these services as is the case in India and Nepal. Shah[125] and others have noted that there are several barriers to patients accessing cataract surgery services within Cape Town.This may be a factor in this unusual finding of a largely urban based population.

2. PREOPERATIVE CHARACTERISTICS

Preoperative visual acuity was found to be less than 6/60 in 61.13% of the PHACO group and 96.45% of the MSICS group.This level of visual impairment in the better eye if categorised by the Word Health Organization[9] recognizes that the patient is severely visually impaired , or economically blind.In the study by Zaidi et al[124] , the preoperative visual acuity mode was 6/36.This was similar to the mean visual acuity of 6/48 reported by Riley et al.These developed country reports have significantly better vision that those reported above.Ruit et al in a developing world study reported that 22.2% of eyes undergoing phacoemulsification and 24.1% of eyes undergoing MSICS, had hand movements or worse visual acuity.My findings of preoperative visual acuity are in keeping with those described by Venkatesh et al[60] in India,where 88.5% of patients had a preoperative visual acuity range from perception of light and 5/60.Similarly Surka et al[123] in South African academic hospital study documented that all their cases were mature cataracts, which implies poor vision. These imply significant visual loss , and also imply advanced cataracts which are known to be harder with increased risk of complications.[126]

Systemic medical and ocular comorbidities were present , with diabetes (without diabetic retinopathy) present in 21.65% and 17.54% of the phaco and MSICS groups respectively.Diabetes with diabetic retinopathy present in 14.67% in the phaco group and 9.36% of the MSIC group.In total diabetes was present in 267 eyes of 736 eyes(36.3%) in the phaco group and in 46 eyes of 171 eyes(26.9%) in the MSICS group.These figures exceed the 4 eyes (in diabetics) out of 98 eyes documented by Surka et al in a rural South African population.Riley et al reported that 46% of their patients had hypertension and 20% had diabetes. Thus, the groups that have been reported have a significant burden of diabetes. This has relevance in that diabetes can be associated with poorer outcomes and increased risk of diabetic retinopathy progression.[127;128]

Age related macular degeneration was documented in 23 cases(3.13%) in the phaco group , with 0 cases in the MSICS group.This is lower than the 5.1% reported by Riley et al in a PHACO series.Hennig et al[70] in a study of 500 MSICS cases documented a single case of macular degeneration in a predominantly Asian population and Surka et al[123] reported zero cases in their rural population.

The low numbers of patients with pseudoexfoliation syndrome,ocular trauma and zonular abnormalities is most probably due to underreporting, this will probably be higher in a prospective study.

Preoperative keratometric astigmatism showed that 58.21% of eyes in the PHACO group and 51.46% of those in the MSICS group had less than 1 dioptre of astigmatism.A further 31.92% of the PHACO group and 35.09% of the MSICS group had 1 to 1.99dioptre of astigmatism.The nature of the astigmatism in terms of "with the rule" or "against the rule" were not captured.Postoperative keratometric astigmatism showed a worsening of astigmatism in both groups, with 42.09% of the PHACO group and 17.89% of the MSICS group having less than 1 dioptre of astigmatism.

3. DETAILS OF SURGERY

Registrars were listed as principal surgeons in 74.18% of the phaco group and in 55.56% of the MSICS group.Registrars as principal surgeons in the phaco group was found to be a significantly more than the MSICS group.It was also noted that surgery was not supervised by a consultant in 95.98% of PHACO eyes and in 63.87% of the MSICS groups.This finding of predominant registrar unsupervised surgery is remarkable ,as registrars are by the nature of their need for training in need of continuous supervision. Surka et al[123] makes no reference to this. However, Zaidi et al[124] in a large United Kingdom study indicates that the specialist registrar was listed as the first surgeon in 41% of cases, a senior house office in 25.5% , a clinical fellow in 17.0% and a consultant in 16.5% of cases. Zaidi et al[46] also noted that all cases were supervised by consultants.No details of supervision were provided by Kothari et al[17] in their Indian teaching hospital experience.Earlier studies in the United States refer to registrars being supervised carefully.[43;45;75]

Foldable intraocular lenses were placed in 81.66% of the PHACO group, this is in keeping with accepted practice in phacoemulsification surgery. Polymethylacrylate intraocular lenses were placed in 94.74% of the MSICS group, this is also done in both Nepal and India.[59;60]Polymethylacrylate lenses are used both in the PHACO group ,as well as in the MSICS group as a cost saving measure.They are also used when ciliary sulcus fixation of an intraocular lens is required.Eyes are left aphakic in the presence of complications and poor visibility.This occurred in 1.22% of the PHACO group and in 1.18% of the MSICS group.

Temporal wound construction occurred in 53.13% of the PHACO eyes ,with a further 22.96% occurring superotemporally.All cases were clear corneal.This move to temporal clear corneal incisions had been reported worldwide.[47;129-135] In the MSICS group 98.83% of cases had a superior scleral tunnel wound.This is keeping with the current accepted technique[27;59;70] ,though some authors also described performing the technique temporally.

4. FIRST VISIT OUTCOMES

Uncorrected visual acuity was 6/18 or better in 60.18% of the PHACO group and in 37.78% of the MSICS group.The poorer initial outcome in the MSICS group was statistically significant.Fortunately both groups showed improvements at the last visit.This contrasts with Hennig et al[59] MSICS study where 76.8% of eyes achieved 6/18 or better on day 2.

Corneal oedema was more common in the MSICS group at 55.42% than in the PHACO group which had corneal oedema in 38.54% of eyes.This may very well be responsible to poorer outcome however visual outcome in the group with corneal oedema was not analysed as a subgroup.No uniform corneal oedema grading system was in use , thus its reporting is subjective.No further analysis was performed with regards to the incidence of corneal oedema.

5. FINAL VISIT OUTCOMES

Uncorrected visual acuity was 6/18 or better in 73.56% in the PHACO group and in 65.77% of the MSICS group,this difference was not statistically significant.

Hennig et al reported that at 6 weeks 70.5% of MSICS eyes had a visual acuity of 6/18 or better.Venkatesh et al reported that at day 40 , 43.9% of eyes achieved an uncorrected visual acuity of 6/18 or better.Riley et al reported that 90.5% achieved 6/18 or better in a New Zealand study. My MSICS results fall in between these two large studies,however both of them are by expert surgeons. My PHACO uncorrected visual acuity results fall below those achieved by Riley et al. Both the PHACO group and MSICS group fall under the recommendation by Foster[11] that 80% or more should achieve 6/18 or more with available correction , if we assume no correction is available.

Uncorrected visual acuity was 5/60 or less in 8.27% of the PHACO group and in 12.75% of the MSICS group.The recommendation by Foster is that with best available correction less than 5% of eyes should be 5/60 or less.[11]

Uncorrected visual acuity was 6/12 or better in 52.29% of the phaco group and in 33.56% of the MSICS , with statistical significance.In the phaco group this is lower than the 67.7% reported by Riley et al[47] and the mode of 6/9 reported by Zaidi et al.[124] Typically MSICS studies use the 6/18 or better benchmark reported above.

Best corrected visual acuity was 6/12 or better in 87.76% of PHACO eyes and 88.1% of MSICS eyes,this difference was not statistically significant.Lundstrom et al[48] in a European survey reported that 85.4% of eyes were 6/12 or better.

Best corrected visual acuity was 6/9 or better in 79.59% of PHACO eyes and 64.29% of MSICS eyes.This difference of better outcome in the PHACO group was statistically significant.

Best corrected visual acuity was 6/18 or better in 95.4% of the PHACO group and 97.62% of the MSICS group.These figures exceed the 94.4% reported in Venkatesh et al[60] MSICS study, as well as the 96.2% reported by Hennig et al.[59]

Best corrected outcomes should be viewed with caution as of the patients who presented for the final visit,a large number had no recorded best corrected visual acuities(385 eyes in the phaco group and 105 eyes in the MSICS group).This could be as a result of lack of clinic time for a subjective refraction,lack of interest by the surgeon,or referral to an optometrist for the final refraction.

Substratification of visual outcome by complications was not performed.Several authors have documented worse outcomes in those eyes with vitreous loss.[17]

6. COMPLICATIONS

Intraoperative complications occurred in 7.34% of the PHACO group and in 12.87% of the MSICS group.There were significantly fewer complications in the phaco group.Hennig et reported 1.9% of eyes had intraoperative complications in an expert based MSICS study.

The posterior capsule rupture rate was 3.94% in the phaco group and 7.6% in the MSICS .This difference was significant.

Vitreous loss occurred in 3.2% of the phaco group and in 5.2% of the MSICS group.Kothari et al [17]quoted a vitreous loss rate of 5% in their phaco group and 8.1% in their MSICS group,this occurred in an Indian teaching hospital. Kelman[30] reported vitreous loss in 16% of his first cases.Zaidi et al[124] reported 1.1% frequency in a United Kingdom study.Smith and Seif[89] in an early study reported decreasing PHACO vitreous loss rates from 16% in the first year of residency to 6% in the third year of residency.Venkatesh et al[60] in an expert MSICS study reported vitreous loss in 0.7% of cases.

"Dropped" nuclear fragments occurred in 2 patients in the PHACO group. Riley et al[47] in smaller study of 488 eyes reported 4 cases of dropped lens fragments. Zaidi reported 1 case of dropped nucleus(0.1%).

Postoperative complications occurred in 12.09% of the phaco group and in 15.79% of the MSICS group.Riley et al[47] and Kothari et al [17]did not categorise the percentage of postoperative complications in their studies. Zaidi et al reported that the total incidence of complications (both intraoperative and postoperative) was 8.7% in United Kingdom PHACO study.

Cystoid macular oedema occurred in 1.09% of the PHACO group and in 0.58% of the MSICS group.In PHACO studies Zaidi et al[124] reported this complication in 1.2% of eyes and Riley et al[47] reported 3.8% at 4 weeks.Kothari et al[17] reported cystoid macular oedema in 11.35% cases that had vitreous loss and in 5.67% of cases without vitreous loss. this was a predominantly MSICS study.

Bacterial endophthalmitis occurred in 0.68% of the PHACO eyes,with no cases reported in the MSICS group.This rate is higher than the rate reported by the European Society of Cataract and Refractive Surgeons.[136]They reported that with the use of intracameral cefuroxime which was the case in our study,the rate was lower 0.08%.It is also significant higher than the 0.1% reported by Zaidi et al[124] and the 0.2% reported by Riley et al.[47]

Retinal detachment occurred in 1 case in the phaco group. Zaidi et al reported 2 cases of retinal detachment (0.2%) frequency in their PHACO study. Posterior capsule opacification occurred in 12 patients(1.63%) in the PHACO group and in 6 eyes(3.51%) in the MSICS group.This rate is underestimated due to short duration of follow-up ,namely a maximum of 10 weeks.Thompson et al[137] in a follow-up of cases reported originally by Riley et al,reported that the 2 year posterior capsule opacification rate was 20.4%.

7. SECONDARY SURGICAL PROCEDURES

The commonest procedures performed included argon laser photocoagulation and macular laser.No pan retinal photocoagulation occurred in the MSICS group,this might me a manifestation of the surgeons' preference for phacoemulsification in this group.Other unknown factors may also be be responsible.Posterior capsule capsulotomy was performed in 2 eyes.It is difficult to compare these findings to other studies without adequate and consistent gradings ,so that comparison can be made.

Pars plana vitrectomies were performed for retinal detachment and for dropped lens fragments in the PHACO.These findings compare favourably to both those reported by Zaidi et al[124] and Riley et al[47].

(5)CONCLUSION

In the first part of this thesis I presented data related to outcomes and complications of cataract surgery using the PHACO and MSICS techniques.I also presented an overview of older forms of cataract surgery including ECCE and ICCE.

In the second part of this thesis,outcomes and complications of cataract surgery in a South African training hospital were presented.

Preoperative visual impairment was severe with the majority of patients being regarded as economically blind.This confirms that cataract surgery is being performed on those who need the service the most,as opposed to those with milder degrees of impairment.

Registrar-led cataract surgery predominates with the majority being unsupervised. Thus our review of the postoperative outcomes should bear this in mind,our findings could well be better with improved supervision.

Our surgical practices, including the use of temporal clear corneal incisions and foldable intraocular lenses for phacoemulsification,is in keeping with accepted practice.MSICS is also performed within the parameters described in Nepal and India.

Visual outcomes at the first visit with a visual acuity of 6/18 or more in 60.18% of the PHACO group and 37.78% of the MSICS groups is disappointing.However the visual outcomes at the final visit in both the PHACO(73.56%) and MSICS(65.77%) groups of visual acuity of 6/18 or better,meet the standards of contemporary studies in respect to MSICS[27;59] eyes but fall below those of a PHACO study.[47] Best corrected visual outcomes of 6/18 or better were in over 95% of the PHACO and MSICS groups.These are in keeping with the standard proposed by Foster.[11]Of concern is the large number of unspecified best corrected visual acuities in those who presented for the last visit.Better staffing and attention to documenting the final refraction would have lowered the impact of this and improved the validity of these results.

Vitreous loss is a complication of note in any study.In this case it occurred in 3.2% of the PHACO group and in 5.2% of the MSICS group.Our PHACO vitreous loss rates exceed those reported by Zaidi et,but are lower than those reported in registrar

phacoemulsification studies.[43;44;85]The MSICS vitreous loss rate is lower than the 8.1% quoted by Kothari et al.[17]

Endophthalmitis occurred in 0.68% of cases which exceeds the norm of 0.08% . Further investigation and a large study will be needed to determine the cause for this, as intracameral cefuroxime was used during the period of the study.

Thus our findings meet international standards in some aspects , with room for improvement in others.

(6)FUTURE WORK AND UNANSWERED QUESTIONS

In performing this retrospective survey , many questions which I would have liked to answer remain unanswered.Unfortunately this is one of the weaknesses of a retrospective review.I will mention some of these questions below.These will need to be addressed in the future.

Different MSICS techniques have been described including the "fish hook" technique of nucleus delivery by Hennig et al[59] and nucleus delivery by "irrigating vectis" as described by Venkatesh et al.[60] A comparison of these techniques in terms of endothelial cell loss and visual outcomes would be worthwhile to help select the best technique for Vision 2020 programmes.

Cost comparisons of both PHACO and MSICS in a South African context would be valuable for future planning. Currently there is no published data on this.

Cataract surgery affects vision , and thus has an impact on quality of life.Assessment of quality of life pre-and post-cataract surgery using a standardised questionnaire would provide interesting new data in a South African context[23;138-140]

Surgically-induced astigmatism,could not unfortunately be dealt with in my study , due to the poor quality of the thermally printed keratometric readings. A future study comparing the PHACO and MSICS groups with regard to this will provide further valuable information with regards to technique selection in our environment.

The impact of newer technologies used for training should be assessed with regards to their effects on outcomes and complications in South Africa. Smith[141] in a 2005 publication posed the question "Teaching phacoemulsification in US ophthalmology residencies : can the quality be maintained?" Smith reported in her review that the median number of cataract surgeries performed during a United States(US) residency was 100 in 2002.[142] Some of the reasons for this include a shrinking of the available service to the poor public,limited volunteer supervisors, and the commercial pressure to be more productive.Teaching takes time and and results in fewer surgeries being performed.These factors unfortunately also apply to residents training elsewhere particularly in the developed world.Some of the techniques to better equip residents include increased and enhanced wet lab experience on modified animal models.The use of virtual reality simulators and modular

phacoemulsification training technique may enhance the residents' ability to attain skills in a less stressful manner.

The above questions will hopefully be addressed in forthcoming prospective studies.

(7)BIBLIOGRAPHY

Referencing follows the Vancouver style.

(1) Cook C, Kluever H, Mabena L, Limburg H. Rapid assessment of cataract at pension pay points in South Africa. Br J Ophthalmol 2007 Jul;91(7):867-8.

(2) Blodi FC. Cataract Surgery. In: Albert DM, Edwards DD, editors. The History of Ophthalmology. 1 ed. Cambridge,Massachusetts: Blackwell Science; 1996. p. 165-73.

(3) American Academy of Ophthalmology. Surgery for Cataract. Lens and Cataract. 2004-2005 ed. San Francisco , California: American Academy of Ophthalmology; 2004. p. 89-94.

(4) Stulting AA. Blast from the past : The history of cataract abd refractive surgery in South Africa. SA Ophthalmology Journal 2007;2(2):32-9.

(5) Viljoen RD, Meyer D. Treating cataracts - the state of the art in 2005. SA Ophthalmology Journal 2006;1(1):5-14.

(6) Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, et al. Global data on visual impairment in the year 2002. Bull World Health Organ 2004 Nov;82(11):844-51.

(7) Schwab L. A prospective randomized clinical trial of phacoemulsification vs manual sutureless small-incision extracapsular surgery in Nepal. Am J Ophthalmol 2007 Jun;143(6):1069.

(8) Jamison DT. Investing in health. World Development Report 1993.

(9) Ellwein LB, Kupfer C. Strategic issues in preventing cataract blindness in developing countries. Bull World Health Organ 1995;73(5):681-90.

(10) Informal consultation on analysis of blindness prevention outcomes. World Health Organization 1998.

(11) Foster A. A simple method for evaluating cataract surgical services in prevention of blindness programmes. Community Eye Health 1992;(10):2-5.

(12) Davis P. South Africa Set to Eliminate Blindness Due to Cataract Within the Next 5 years. Journal of Age Related disorders 2000 Jul;17.

(13) Rotchford AP, Rotchford KM, Mthethwa LP, Johnson GJ. Reasons for poor cataract surgery uptake - a qualitative study in rural south africa. Tropical Medicine and International Health 2008;7(3):288-92.

(14) Wong D. Auditing cataract surgery nationwide. Br J Ophthalmol 2006 Jul;90(7):817.

(15) Kaufmann C, Peter J, Ooi K, Phipps S, Cooper P, Goggin M. Limbal relaxing incisions versus on-axis incisions to reduce corneal astigmatism at the time of cataract surgery. J Cataract Refract Surg 2005 Dec;31(12):2261-5.

(16) Rao SN, Konowal A, Murchison AE, Epstein RJ. Enlargement of the temporal clear corneal cataract incision to treat pre-existing astigmatism. J Refract Surg 2002 Jul;18(4):463-7.

(17) Kothari M, Thomas R, Parikh R, Braganza A, Kuriakose T, Muliyil J. The incidence of vitreous loss and visual outcome in patients undergoing cataract surgery in a teaching hospital. Indian J Ophthalmol 2003 Mar;51(1):45-52.

(18) Frost NA, Sparrow JM, Strong NP, Rosenthal AR. Vitreous loss in planned extracapsular cataract extraction does lead to a poorer visual outcome. Eye 1995;9 (Pt 4):446-51.

(19) Liu C. Risk stratification for the humble cataract. Br J Ophthalmol 2004 Oct;88(10):1231-2.

(20) Najjar DM, Awwad ST. Cataract surgery risk score for residents and beginning surgeons. J Cataract Refract Surg 2003 Oct;29(10):2036-7.

(21) Limburg H, Foster A, Vaidyanathan K, Murthy GV. Monitoring visual outcome of cataract surgery in India. Bull World Health Organ 1999;77(6):455-60.

(22) Hennig A, Shrestha SP, Foster A. Results and evaluation of high volume intracapsular cataract surgery in Nepal. Acta Ophthalmol (Copenh) 1992 Jun;70(3):402-6.

(23) Fletcher AE, Ellwein LB, Selvaraj S, Vijaykumar V, Rahmathullah R, Thulasiraj RD. Measurements of vision function and quality of life in patients with cataracts in southern India. Report of instrument development. Arch Ophthalmol 1997 Jun;115(6):767-74.

(24) Fletcher A, Vijaykumar V, Selvaraj S, Thulasiraj RD, Ellwein LB. The Madurai Intraocular Lens Study. III: Visual functioning and quality of life outcomes. Am J Ophthalmol 1998 Jan;125(1):26-35.

(25) Reidy A, Mehra V, Minassian D, Mahashabde S. Outcome of cataract surgery in central India: a longitudinal follow-up study. Br J Ophthalmol 1991 Feb;75(2):102-5.

(26) Riaz Y, Mehta JS, Wormald R, Evans JR, Foster A, Ravilla T, et al. Surgical interventions for age-related cataract. Cochrane Database Syst Rev 2006;(4):CD001323.

(27) Gogate PM, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi SA, Palimkar A, et al. Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized controlled clinical trial: six-week results. Ophthalmology 2005 May;112(5):869-74.

(28) Powe NR, Schein OD, Gieser SC, Tielsch JM, Luthra R, Javitt J, et al. Synthesis of the literature on visual acuity and complications following cataract extraction with intraocular lens implantation. Cataract Patient Outcome Research Team. Arch Ophthalmol 1994 Feb;112(2):239-52.

(29) Kanski JJ. Lens. Clinical Ophthalmology : A Systematic Approach. 5 ed. London: Butterworth-Heinemann; 2003. p. 170-1.

(30) Kelman CD. Phaco-emulsification and aspiration. A new technique of cataract removal. A preliminary report. Am J Ophthalmol 1967 Jul;64(1):23-35.

(31) Minassian DC, Rosen P, Dart JK, Reidy A, Desai P, Sidhu M, et al. Extracapsular cataract extraction compared with small incision surgery by phacoemulsification: a randomised trial. Br J Ophthalmol 2001 Jul;85(7):822-9.

(32) Devgan U. Surgical techniques in phacoemulsification. Curr Opin Ophthalmol 2007 Feb;18(1):19-22.

(33) Weikert MP. Update on bimanual microincisional cataract surgery. Curr Opin Ophthalmol 2006 Feb;17(1):62-7.

(34) Oshika T, Nagahara K, Yaguchi S, Emi K, Takenaka H, Tsuboi S, et al. Three year prospective, randomized evaluation of intraocular lens implantation through 3.2 and 5.5 mm incisions. J Cataract Refract Surg 1998 Apr;24(4):509-14.

(35) Alio J, Rodriguez-Prats JL, Galal A. Advances in microincision cataract surgery intraocular lenses. Curr Opin Ophthalmol 2006 Feb;17(1):80-93.

(36) Wormald RP. Phacoemulsification vs small-incision manual cataract surgery: an expert trial. Am J Ophthalmol 2007 Jan;143(1):143-4.

(37) George R, Rupauliha P, Sripriya AV, Rajesh PS, Vahan PV, Praveen S. Comparison of endothelial cell loss and surgically induced astigmatism following conventional extracapsular cataract surgery, manual small-incision surgery and phacoemulsification. Ophthalmic Epidemiol 2005 Oct;12(5):293-7.

(38) Ruit S, Tabin G, Chang D, Bajracharya L, Kline DC, Richheimer W, et al. A prospective randomized clinical trial of phacoemulsification vs manual sutureless small-incision extracapsular cataract surgery in Nepal. Am J Ophthalmol 2007 Jan;143(1):32-8.

(39) Prince RB, Tax RL, Miller DH. Conversion to small-incision phacoemulsification: experience with the first 50 eyes. J Cataract Refract Surg 1993 Mar;19(2):246-50.

(40) Chylack LT, Jr., Wolfe JK, Singer DM, Leske MC, Bullimore MA, Bailey IL, et al. The Lens Opacities Classification System III. The Longitudinal Study of Cataract Study Group. Arch Ophthalmol 1993 Jun;111(6):831-6.

(41) Thylefors B, Chylack LT, Jr., Konyama K, Sasaki K, Sperduto R, Taylor HR, et al. A simplified cataract grading system. Ophthalmic Epidemiol 2002 Apr;9(2):83-95.

(42) Najjar DM, Awwad ST. Simple cataract checklist for residents and high-volume surgeons. J Cataract Refract Surg 2003 May;29(5):1046.

(43) Allinson RW, Palmer ML, Fante R, Stanko M. Vitreous loss during phacoemulsification by residents. Ophthalmology 1992 Aug;99(8):1181.

(44) Cruz OA, Wallace GW, Gay CA, Matoba AY, Koch DD. Visual results and complications of phacoemulsification with intraocular lens implantation performed by ophthalmology residents. Ophthalmology 1992 Mar;99(3):448-52.

(45) Browning DJ, Cobo LM. Early experience in extracapsular cataract surgery by residents. Ophthalmology 1985 Dec;92(12):1647-53.

(46) Zaidi FH, Corbett MC, Burton BJ, Bloom PA. Raising the benchmark for the 21st century - the 1000 cataract operations audit and survey: outcomes, Consultant-supervised training and sourcing NHS choice. Br J Ophthalmol 2006 Oct 18.

(47) Riley AF, Malik TY, Grupcheva CN, Fisk MJ, Craig JP, McGhee CN. The Auckland cataract study: co-morbidity, surgical techniques, and clinical outcomes in a public hospital service. Br J Ophthalmol 2002 Feb;86(2):185-90.

(48) Lundstrom M, Barry P, Leite E, Seward H, Stenevi U. 1998 European Cataract Outcome Study: report from the European Cataract Outcome Study Group. J Cataract Refract Surg 2001 Aug;27(8):1176-84.

(49) Schein OD, Steinberg EP, Javitt JC, Cassard SD, Tielsch JM, Steinwachs DM, et al. Variation in cataract surgery practice and clinical outcomes. Ophthalmology 1994 Jun;101(6):1142-52.

(50) Courtney P. The National Cataract Surgery Survey: I. Method and descriptive features. Eye 1992;6 (Pt 5):487-92.

(51) Wegener M, Alsbirk PH, Hojgaard-Olsen K. Outcome of 1000 consecutive clinic- and hospital-based cataract surgeries in a Danish county. J Cataract Refract Surg 1998 Aug;24(8):1152-60.

(52) Desai P, Minassian DC, Reidy A. National cataract surgery survey 1997-8: a report of the results of the clinical outcomes. Br J Ophthalmol 1999 Dec;83(12):1336-40.

(53) Naeser K. Conversion of keratometer readings to polar values. J Cataract Refract Surg 1990 Nov;16(6):741-5.

(54) Blumenthal M, Assia EI, Chen V, Avni I. Using an anterior chamber maintainer to control intraocular pressure during phacoemulsification. J Cataract Refract Surg 1994 Jan;20(1):93-6.

(55) Girard LJ. Origin of the scleral tunnel incision. J Cataract Refract Surg 1995 Jan;21(1):6-7.

(56) Girard LJ. Origin of the scleral tunnel method. J Cataract Refract Surg 1993 Nov;19(6):812-3.

(57) Girard LJ, Rodriguez J, Mailman ML. Reducing surgically induced astigmatism by using a scleral tunnel. Am J Ophthalmol 1984 Apr;97(4):450-6.

(58) Burgansky Z, Isakov I, Avizemer H, Bartov E. Minimal astigmatism after sutureless planned extracapsular cataract extraction. J Cataract Refract Surg 2002 Mar;28(3):499-503.

(59) Hennig A, Kumar J, Yorston D, Foster A. Sutureless cataract surgery with nucleus extraction: outcome of a prospective study in Nepal. Br J Ophthalmol 2003 Mar;87(3):266-70.

(60) Venkatesh R, Muralikrishnan R, Balent LC, Prakash SK, Prajna NV. Outcomes of high volume cataract surgeries in a developing country. Br J Ophthalmol 2005 Sep;89(9):1079-83.

(61) Holladay JT, Cravy TV, Koch DD. Calculating the surgically induced refractive change following ocular surgery. J Cataract Refract Surg 1992 Sep;18(5):429-43.

(62) Gogate PM, Deshpande M, Wormald RP, Deshpande R, Kulkarni SR. Extracapsular cataract surgery compared with manual small incision cataract surgery in community eye care setting in western India: a randomised controlled trial. Br J Ophthalmol 2003 Jun;87(6):667-72.

(63) Kapoor H, Chatterjee A, Daniel R, Foster A. Evaluation of visual outcome of cataract surgery in an Indian eye camp. Br J Ophthalmol 1999 Mar;83(3):343-6.

(64) Prajna NV, Chandrakanth KS, Kim R, Narendran V, Selvakumar S, Rohini G, et al. The Madurai Intraocular Lens Study. II: Clinical outcomes. Am J Ophthalmol 1998 Jan;125(1):14-25.

(65) Prajna NV, Ellwein LB, Selvaraj S, Manjula K, Kupfer C. The madurai intraocular lens study IV: posterior capsule opacification. Am J Ophthalmol 2000 Sep;130(3):304-9.

(66) Acheson JF, McHugh JD, Falcon MG. Changing patterns of early complications in cataract surgery with new techniques: a surgical audit. Br J Ophthalmol 1988 Jul;72(7):481-4.

(67) Cook CD, Evans JR, Johnson GJ. Is anterior chamber lens implantation after intracapsular cataract extraction safe in rural black patients in Africa? A pilot study in KwaZulu-Natal, South Africa. Eye 1998;12 (Pt 5):821-5.

(68) Waddell KM, Reeves BC, Johnson GJ. A comparison of anterior and posterior chamber lenses after cataract extraction in rural Africa: a within patient randomised trial. Br J Ophthalmol 2004 Jun;88(6):734-9.

(69) Snellingen T, Shrestha JK, Huq F, Husain R, Koirala S, Rao GN, et al. The South Asian cataract management study: complications, vision outcomes, and corneal endothelial cell loss in a randomized multicenter clinical trial comparing intracapsular cataract extraction with and without anterior chamber intraocular lens implantation. Ophthalmology 2000 Feb;107(2):231-40.

(70) Hennig A, Johnson GJ, Evans JR, Lagnado R, Poulson A, Pradhan D, et al. Long term clinical outcome of a randomised controlled trial of anterior chamber lenses after high volume intracapsular cataract surgery. Br J Ophthalmol 2001 Jan;85(1):11-7.

(71) Hennig A, Evans JR, Pradhan D, Johnson GJ, Pokhrel RP, Gregson RM, et al. Randomised controlled trial of anterior-chamber intraocular lenses. Lancet 1997 Apr 19;349(9059):1129-33.

(72) Yorston D, Foster A. Audit of extracapsular cataract extraction and posterior chamber lens implantation as a routine treatment for age related cataract in east Africa. Br J Ophthalmol 1999 Aug;83(8):897-901.

(73) Cataract surgery: interim results and complications of a randomised controlled trial. Oxford Cataract Treatment and Evaluation Team (OCTET). Br J Ophthalmol 1986 Jun;70(6):402-10.

(74) Use of a grading system in the evaluation of complications in a randomised controlled trial on cataract surgery. Oxford Cataract Treatment and Evaluation Team (OCTET). Br J Ophthalmol 1986 Jun;70(6):411-4.

(75) Allinson RW, Metrikin DC, Fante RG. Incidence of vitreous loss among third-year residents performing phacoemulsification. Ophthalmology 1992 May;99(5):726-30.

(76) Vail D. After-results of vitreous loss. Am J Ophthalmol 1965 Apr;59:573-86.

(77) MAUMENEE AE. Symposium: postoperative cataract complications. III. Epithelial invasion of the anterior chamber: retinal detachment; corneal edema, anterior chamber hemorrhages, changes in the macula. Trans Am Acad Ophthalmol Otolaryngol 1957 Jan;61(1):51-68.

(78) Gass JD. Management of vitreous loss after cataract extraction. Arch Ophthalmol 1970 Mar;83(3):319-23.

(79) Peyman GA, Sanders DR. Vitrectomy instrumentation. Trans Ophthalmol Soc N Z 1977;29:31-4.

(80) Peyman GA, Sanders DR. Management of vitreous loss during cataract surgery. Ophthalmic Surg 1977 Oct;8(5):40-1.

(81) Berger BB, Zweig KO, Peyman GA. Vitreous loss managed by anterior vitrectomy. Long-term follow-up of 59 cases. Arch Ophthalmol 1980 Jul;98(7):1245-7.

(82) Kelman CD. Symposium: Phacoemulsification. History of emulsification and aspiration of senile cataracts. Trans Am Acad Ophthalmol Otolaryngol 1974 Jan;78(1):OP5-13.

(83) Kelman CD. Symposium: Phacoemulsification. Summary of personal experience. Trans Am Acad Ophthalmol Otolaryngol 1974 Jan;78(1):OP35-OP38.

(84) Gimbel HV. Posterior Capsule Tears during Phaco-emulsification Causes , Prevention and Management. Eur J Implant Ref Surg 1990;2(March):62-9.

(85) Cotlier E, Rose M. Cataract extraction by the intracapsular methods and by phacoemulsification: the results of surgeons in training. Trans Sect Ophthalmol Am Acad Ophthalmol Otolaryngol 1976 Jan;81(1):OP163-OP182.

(86) Pearson PA, Owen DG, Van Meter WS, Smith TJ. Vitreous loss rates in extracapsular cataract surgery by residents. Ophthalmology 1989 Aug;96(8):1225-7.

(87) Quillen DA, Phipps SJ. Visual outcomes and incidence of vitreous loss for residents performing phacoemulsification without prior planned extracapsular cataract extraction experience. Am J Ophthalmol 2003 May;135(5):732-3.

(88) Corey RP, Olson RJ. Surgical outcomes of cataract extractions performed by residents using phacoemulsification. J Cataract Refract Surg 1998 Jan;24(1):66-72.

(89) Smith JH, Seiff SR. Outcomes of cataract surgery by residents at a public county hospital. Am J Ophthalmol 1997 Apr;123(4):448-54.

(90) Tarbet KJ, Mamalis N, Theurer J, Jones BD, Olson RJ. Complications and results of phacoemulsification performed by residents. J Cataract Refract Surg 1995 Nov;21(6):661-5.

(91) Tayanithi P, Pungpapong K, Siramput P. Vitreous loss during phacoemulsification learning curve performed by third-year residents. J Med Assoc Thai 2005 Nov;88 Suppl 9:S89-S93.

(92) Claoue C, Steele A. Visual prognosis following accidental vitreous loss during cataract surgery. Eye 1993;7 (Pt 6):735-9.

(93) Sappenfield DL, Driebe WT, Jr. Resident extracapsular cataract surgery: results and a comparison of automated and manual techniques. Ophthalmic Surg 1989 Sep;20(9):619-24.

(94) Nishi O. Vitreous loss in posterior chamber lens implantation. J Cataract Refract Surg 1987 Jul;13(4):424-7.

(95) Jaffe NS. Results of intraocular lens implant surgery. The third Binkhorst medal lecture. Am J Ophthalmol 1978 Jan;85(1):13-23.

(96) Egbert PR, Buchanan M. Results of extracapsular cataract surgery and intraocular lens implantation in Ghana. Arch Ophthalmol 1991 Dec;109(12):1764-8.

(97) Cook NJ. Evaluation of high volume extracapsular cataract extraction with posterior chamber lens implantation in Sierra Leone, west Africa. Br J Ophthalmol 1996 Aug;80(8):698-701.

(98) Ursell PG, Spalton DJ, Whitcup SM, Nussenblatt RB. Cystoid macular edema after phacoemulsification: relationship to blood-aqueous barrier damage and visual acuity. J Cataract Refract Surg 1999 Nov;25(11):1492-7.

(99) Miyake K, Masuda K, Shirato S, Oshika T, Eguchi K, Hoshi H, et al. [Preventive effects of diclofenac ophthalmic solution on post-cataract-surgical cystoid macular edema]. Nippon Ganka Gakkai Zasshi 1998 Aug;102(8):522-30.

(100) Mentes J, Erakgun T, Afrashi F, Kerci G. Incidence of cystoid macular edema after uncomplicated phacoemulsification. Ophthalmologica 2003 Nov;217(6):408-12.

(101) Gehring JR. Macular edema following cataract extraction. Arch Ophthalmol 1968 Nov;80(5):626-31.

(102) Taylor DM, Sachs SW, Stern AL. Aphakic cystoid macular edema. Longterm clinical observations. Surv Ophthalmol 1984 May;28 Suppl:437-41.

(103) Cystoid macular edema in aphakic and pseudophakic eyes. Am J Ophthalmol 1979 Jul;88(1):45-8.

(104) Shepard DD. Intraocular lens implantation -- analysis of 500 consecutive cases. Ophthalmic Surg 1977 Jun;8(3):57-63.

(105) Stern AL, Taylor DM, Dalburg LA, Cosentino RT. Pseudophakic cystoid maculopathy: a study of 50 cases. Ophthalmology 1981 Sep;88(9):942-6.

(106) Yoshioka H, Kawashima K, Sugita T. [Cystoid macular edema following cataract extraction. 2]. Nippon Ganka Gakkai Zasshi 1972 Sep;76(9):1118-24.

(107) Hitchings RA. Aphakic macular oedema: a two-year follow-up study. Br J Ophthalmol 1977 Oct;61(10):628-30.

(108) Ruiz RS, Saatci OA. Visual outcome in pseudophakic eyes with clinical cystoid macular edema. Ophthalmic Surg 1991 Apr;22(4):190-3.

(109) Kraff MC, Sanders DR, Jampol LM, Lieberman HL. Effect of primary capsulotomy with extracapsular surgery on the incidence of pseudophakic cystoid macular edema. Am J Ophthalmol 1984 Aug 15;98(2):166-70.

(110) Kraff MC, Sanders DR, Jampol LM, Lieberman HL. Effect of primary capsulotomy with extracapsular surgery on the incidence of pseudophakic cystoid macular edema. Am J Ophthalmol 1984 Aug 15;98(2):166-70.

(111) Wright PL, Wilkinson CP, Balyeat HD, Popham J, Reinke M. Angiographic cystoid macular edema after posterior chamber lens implantation. Arch Ophthalmol 1988 Jun;106(6):740-4.

(112) Javitt JC, Vitale S, Canner JK, Street DA, Krakauer H, McBean AM, et al. National outcomes of cataract extraction. Endophthalmitis following inpatient surgery. Arch Ophthalmol 1991 Aug;109(8):1085-9.

(113) Aaberg TM, Jr., Flynn HW, Jr., Schiffman J, Newton J. Nosocomial acute-onset postoperative endophthalmitis survey. A 10-year review of incidence and outcomes. Ophthalmology 1998 Jun;105(6):1004-10.

(114) Barry P, Seal DV, Gettinby G, Lees F, Peterson M, Revie CW. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: Preliminary report of principal results from a European multicenter study. J Cataract Refract Surg 2006 Mar;32(3):407-10.

(115) Kelly SP, Mathews D, Mathews J, Vail A. Reflective consideration of postoperative endophthalmitis as a quality marker. Eye 2007 Nov;21(11):1419-26.

(116) Alhassan MB, Kyari F, Achi IB, Ozemela CP, Abiose A. Audit of outcome of an extracapsular cataract extraction and posterior chamber intraocular lens training course. Br J Ophthalmol 2000 Aug;84(8):848-51.

(117) Snellingen T, Shrestha JK, Huq F, Husain R, Koirala S, Rao GN, et al. The South Asian cataract management study: complications, vision outcomes, and corneal endothelial cell loss in a randomized multicenter clinical trial comparing intracapsular cataract extraction with and without anterior chamber intraocular lens implantation. Ophthalmology 2000 Feb;107(2):231-40.

(118) Hennig A, Evans JR, Pradhan D, Johnson GJ, Pokhrel RP, Gregson RM, et al. Randomised controlled trial of anterior-chamber intraocular lenses. Lancet 1997 Apr 19;349(9059):1129-33.

(119) Long-term corneal endothelial cell loss after cataract surgery. Results of a randomized controlled trial. Oxford Cataract Treatment and Evaluation Team (OCTET). Arch Ophthalmol 1986 Aug;104(8):1170-5.

(120) Brown PR, Thomas RP. The low incidence of primary retinal detachment in the negro. Am J Ophthalmol 1965 Jul;60:109-10.

(121) Staz L. Detachment of the retina; some practical experiences in the operative treatment. S Afr Med J 1949 Aug 13;23(33):683-7.

(122) Fernando GT, Crayford BB. Visually significant calcification of hydrogel intraocular lenses necessitating explantation. Clin Experiment Ophthalmol 2000 Aug;28(4):280-6.

(123) Surka J, Hussain S. Outcome of high-volume cataract surgery at an academic hospital. S Afr Med J 2001 Sep;91(9):771-4.

(124) Zaidi FH, Corbett MC, Burton BJ, Bloom PA. Raising the benchmark for the 21st century--the 1000 cataract operations audit and survey: outcomes, consultant-supervised training and sourcing NHS choice. Br J Ophthalmol 2007 Jun;91(6):731-6.

(125) Shah A. Barriers to the uptake of cataract surgery for women in urban Cape Town. Community Eye Health 2005 Mar;18(53):80.

(126) Singh R, Vasavada AR, Janaswamy G. Phacoemulsification of brunescent and black cataracts. J Cataract Refract Surg 2001 Nov;27(11):1762-9.

(127) Antcliff RJ, Poulson A, Flanagan DW. Phacoemulsification in diabetics. Eye 1996;10 (Pt 6):737-41.

(128) Somaiya MD, Burns JD, Mintz R, Warren RE, Uchida T, Godley BF. Factors affecting visual outcomes after small-incision phacoemulsification in diabetic patients. J Cataract Refract Surg 2002 Aug;28(8):1364-71.

(129) Barequet IS, Yu E, Vitale S, Cassard S, Azar DT, Stark WJ. Astigmatism outcomes of horizontal temporal versus nasal clear corneal incision cataract surgery. J Cataract Refract Surg 2004 Feb;30(2):418-23.

(130) Borasio E, Mehta JS, Maurino V. Surgically induced astigmatism after phacoemulsification in eyes with mild to moderate corneal astigmatism: temporal versus on-axis clear corneal incisions. J Cataract Refract Surg 2006 Apr;32(4):565-72.

(131) Cillino S, Morreale D, Mauceri A, Ajovalasit C, Ponte F. Temporal versus superior approach phacoemulsification: short-term postoperative astigmatism. J Cataract Refract Surg 1997 Mar;23(2):267-71.

(131) Cillino S, Morreale D, Mauceri A, Ajovalasit C, Ponte F. Temporal versus superior approach phacoemulsification: short-term postoperative astigmatism. J Cataract Refract Surg 1997 Mar;23(2):267-71.

(132) Ermis SS, Inan UU, Ozturk F. Surgically induced astigmatism after superotemporal and superonasal clear corneal incisions in phacoemulsification. J Cataract Refract Surg 2004 Jun;30(6):1316-9.

(133) Masket S, Tennen DG. Astigmatic stabilization of 3.0 mm temporal clear corneal cataract incisions. J Cataract Refract Surg 1996 Dec;22(10):1451-5.

(134) Roman S, Ullern M. [Astigmatism caused by superior and temporal corneal incisions in cataract surgery]. J Fr Ophtalmol 1997;20(4):277-83.

(135) Roman SJ, Auclin FX, Chong-Sit DA, Ullern MM. Surgically induced astigmatism with superior and temporal incisions in cases of with-the-rule preoperative astigmatism. J Cataract Refract Surg 1998 Dec;24(12):1636-41.

(136) Seal DV, Barry P, Gettinby G, Lees F, Peterson M, Revie CW, et al. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: Case for a European multicenter study. J Cataract Refract Surg 2006 Mar;32(3):396-406.

(137) Thompson AM, Sachdev N, Wong T, Riley AF, Grupcheva CN, McGhee CN. The Auckland Cataract Study: 2 year postoperative assessment of aspects of clinical, visual, corneal topographic and satisfaction outcomes. Br J Ophthalmol 2004 Aug;88(8):1042-8.

(138) Ellwein LB, Fletcher A, Negrel AD, Thulasiraj RD. Quality of life assessment in blindness prevention interventions. Int Ophthalmol 1994;18(5):263-8.

(139) Lundstrom M, Stenevi U, Thorburn W. Quality of life after first- and second-eye cataract surgery: five-year data collected by the Swedish National Cataract Register. J Cataract Refract Surg 2001 Oct;27(10):1553-9.

(140) Althin R, Lundstrom M, Roos P. A new index approach to measure lost benefits from progression to blindness. Int J Technol Assess Health Care 2002;18(3):635-44.

(141) Smith JH. Teaching phacoemulsification in US ophthalmology residencies: can the quality be maintained? Curr Opin Ophthalmol 2005 Feb;16(1):27-32.

(142) Rowden A, Krishna R. Resident cataract surgical training in United States residency programs. J Cataract Refract Surg 2002 Dec;28(12):2202-5.

(8)APPENDICES

APPENDIX I : MODIFIED WORLD HEALTH ORGANISATION CATEGORIES OF VISUAL IMPAIRTMENT AND SUGGESTED TARGETS FOR CATARACT SURGERY OUTCOMES IN BLINDNESS ALLEVIATION PROGRAMMES[9-11;116]

Postoperative Snellen visual acuity	Available Correction(recommended)	Best Correction(recommended)
Good (6/6-6/18)	80% or more	90% or more
Borderline(<6/18-6/60)	15% or less	5% or less
Poor(<6/60)	5% or less	5% or less

APPENDIX II : DATA COLLECTION FORM FOR STUDY PATIENTS

PREOP DATA		Coding
Name		
Hospital number		
Date of Birth		
Age (years)		
Gender (male, female)	Male 1 Female 2	
Domicile (metro, outside metro)	Metro 1 Outside Metro 2	
Preoperative visual acuity right eye - uncorrected	PL 1 6/18 10 HM 2 6/15 11 CF 3 6/12 12 6/60 4 6/9 13 6/36 5 6/7.5 14 6/30 6 6/6 15 6/24 7 6/4.5 16 6/20 8 NPL 17 Unspecified 99	
Preoperative visual acuity left eye -uncorrected	PL 1 6/18 10 HM 2 6/15 11 CF 3 6/12 12 6/60 4 6/9 13 6/36 5 6/7.5 14 6/30 6 6/6 15 6/24 7 6/4.5 16 6/20 8 NPL 17 Unspecified 99	
Preoperative K readings right eye	K1 AXIS K2 AXIS	
Preoperative K readings left eye	K1 AXIS K2 AXIS	
Calculated IOL power for emmetropia-Right (using A –constant of implanted IOL)		
Calculated IOL power for emmetropia – Left (using A –constant of implanted IOL)		
Biometrist	• Pat 1 Doctor 3 • Farieda 2 Unknown 99	

Eye for surgery (right, left)	Right 1 Left 2	
Comorbidity	• Diabetes 1 • Diabetic Retinopathy 2 • Macular Degeneration (AMD) 3 • Glaucoma 4 • Pseudoexfoliation 5 • Ocular Trauma 6 • Central Retinal Vein Occlusion 7 • Other 8	
SURGICAL DATA		Coding
Date of Surgery (dd/mm/yy)	___/___/_____	--------
Surgeon	Abrahmse 1 Rice 12 Albrecht 2 Sara 13 Bvumbi 3 Van heerden 14 Cockburn 4 Van velden 15 Cook 5 Van der merwe 16 Du toit 6 Woodcock 17 Glover 7 Steven 18 Leucona 8 Khumalo 19 Leonard 10 Kidson 20 Motala 11 Wittles 21 Unknown 99 Vayanos 22	
Leonard 23 Other 24		
Supervisor	Unsupervised 1 Registrar 3 Consultant 2	
Training Surgery	Yes 1 No 2	
Type of surgery (phaco, ECCE)	Phaco-divide and conquer 1 Phaco – chop 2 ECCE-Small incision 3 Phacoconversion 4 ECCE-large incision 5 ICCE 6 Other 7	
Surgical Wound In phaco/ECCE	Superior 1 In between 3 Temporal 2	
IOL type	FOLDABLE 1 PMMA 2 UNKNOWN 99 APHAKIA 3	
IOL Placement Site	Bag 1 AC-IOL 3 Sulcus 2 Unknown 99	
IOL Power		
IOL A - Constant		
Intraoperative complication(s)	Capsule rupture without vitreous loss 1 Capsule rupture with vitreous loss 2 Dropped nuclear or lens fragments 3 Suprachoroidal (expulsive) haemorrhage 4 Other 5	

DAY 2 TO 10 POSTOP		Coding
Date of visit(dd/mm/yyyy)	___/___/_____	
Days from Surgery		
Uncorrected visual acuity	PL 1 6/18 10 HM 2 6/15 11 CF 3 6/12 12 6/60 4 6/9 13 6/36 5 6/7.5 14 6/30 6 6/6 15 6/24 7 6/4.5 16 6/20 8 NPL 17 Unspecified 99	
Corneal oedema	Yes 1 No 2 Unspecified 99	

FINAL POSTOP	**WEEK 1-10**	Coding
Date last seen(dd/mm/yyyy)	___/___/____	
Days from surgery	7 – 70 days	
Uncorrected visual acuity	PL 1 6/18 10 HM 2 6/15 11 CF 3 6/12 12 6/60 4 6/9 13 6/36 5 6/7.5 14 6/30 6 6/6 15 6/24 7 6/4.5 16 6/20 8 NPL 17 Unspecified 99	
Best corrected visual acuity	PL 1 6/18 10 HM 2 6/15 11 CF 3 6/12 12 6/60 4 6/9 13 6/36 5 6/7.5 14 6/30 6 6/6 15 6/24 7 6/4.5 16 6/20 8 NPL 17 Unspecified 99	
K readings for operated eye	K1 AXIS K2 AXIS NOT RECORDED 99	
Refraction- for operated eye	• Sphere • Cyl • Axis • SE	

	• Not Recorded 99	
Post operative complication(s)	• Cystoid macular oedema 1 • Retinal detachment 2 • Corneal decompensation 3 • Endophthalmitis 4 • Other 5 • PCO 6 • Diabetic Mac oedema 7	
Secondary Surgical Procedures Performed	• Displaced IOL repositioning 1 • Displaced IOL removal 2 • Pars plana Vitrectomy for Ret Det 3 • Pars plana Vitrectomy for Lensfrag 4 • Intravitreal Antibiotics and taps 5 • Evisceration 6 • Anterior chamber IOL 7 • Sutured in IOL 8 • Repair Wound Dehiscence 10 • YAG Capsulotomy 11 • Pan Retinal photocoagulation 12 • Macula Focal laser 13 • YAG to vitreous strand 14 • Other 15	
Cause of Poor Outcome < 6/18	• Comorbidity 1 • Intraoperative Complication 2 • Postoperative Complication 3 • Uncorrected refractive error 4 • Unknown 99	
Preop K Readings illegible	Yes 1	
Biometry illegible	Yes 1	
Postoperative K – Readings/Autoref illegible	Yes 1	
Refract Done beyond LV	Yes 1	
Only eye operated on (in 2006)	Yes 1	
First Eye / Second eye	First Eye 1 Second Eye 2	
Other Eye operated on nonproject list	Yes 1	
Pt did not present for first visit	Yes 1	
Pt did not present for last visit	Yes 1	
COMMENTS		