ISM skriftserie Nr. 54

THE SOUTH ASIAN CATARACT MANAGEMENT STUDY

Torkel Snellingen

Tromsø 2000

Institute of Community Medicine
University of Tromsø, Norway

ISM skriftserie
blir utgitt av Institutt for samfunnsmedisin
Universitetet i Tromsø.

Forfatterne er selv ansvarlige for sine funn og konklusjoner. Innholdet er derfor ikke uttrykk for ISM's syn.

The opinions expressed in this publication are those of the authors and do not necessarily reflect the official policy of the institutions supporting this research.

ISBN 82 - 90262 - 61 - 2
2000

The South Asian Cataract Management Study

A prospective clinical study of traditional intracapsular cataract surgery with and without implantation of anterior chamber intraocular lens

by

Torkel Snellingen

to have or not to have a lens implant... that is the question.

Renouncing the glory at which
the world aims, I desire only
to know the truth

Plato

TABLE OF CONTENTS

ACKNOWLEDGMENTS

A project resulting in a doctoral thesis is often a lonesome road where isolation, patience and a flare for the picky details are necessary virtues.

When I embarked on the doctoral fellowship I was not convinced that I could identify with such an enterprise and that I really did not have the «academic» personality (as some surely still are convinced) to embark on a higher degree as this. For quite sometime I was living with an uneasy feeling that the whole initiative was too ambitious and possibly a grand mistake.

Most projects starts with enthusiasm, followed by contemplation and cautious expectation and then by despair, and if concluded, end up in a soft emotion of ... what now?? After the initial enthusiasm with the development of the project operation reality struck hard when the time came for the first data analysis and the first measly attempts at drafting a manuscript or as my supervisor called it - «første utkast til kladd» or *the first draft of the draft's draft!*.

After toiling through the n^{th} draft, it is therefore with great satisfaction that, together with the concerted effort of a wonderful team of co-workers, this project can be presented here as a doctoral dissertation.

Although some sacrifice was needed from the academic and medico-surgical side the real «heroes» of this project were the ophthalmic assistants, drivers and field workers without whose endurance in pursuing the patient follow-up, this project would have been a failure. I am especially grateful to all the members of the project team: Mukti, Suresh, Janardan, Ravi, Roma, Monawara, Enramul, Ramesh, Sharda, Sree Lakshmee and drivers Daniel and, Chalan for their hard work and dedication to the project.

The dissertation could easily be followed by a more general documentary. Here I would like to mention one story to illustrate the sacrifice of the field staff.

Daniel, who functioned both as a driver cum field worker in Hyderabad, was on one occasion pursuing one of the patients that had not met for the scheduled follow-up. Upon arrival in the patient's village however, instead of receiving help to find the patient he was detained by the village people suspected of being a child kidnapper. He was locked in a room without food or water until the next day. It was not until he could convince the villagers to contact the police and he could explain his real business to them that he was released from detention.

The seeds of this project were sown early on thanks to Akhtar Hussain who first awakened my curiosity to south Asia and the issue of world blindness. Akhtar subsequently gave me the opportunity to get to know his beautiful country of Bangladesh. It has been wonderful to catch up with Akhtar in Oslo in his new post as epidemiologist at the National Hospital. My praise goes to him on his impressive dissertation on Night Blindness in Bangladesh.

Albert Kolstad deserves appreciation for giving the young medical intern the first exposure through his invitation to work with him at the Geta Eye Hospital in western Nepal. Albert's continuing advice and encouragement for this project has been invaluable. I would also like to mention the contributions of Oddvar Otterlei and Richard Dingley who, with

their wealth of experience working in the developing country setting, gave me valuable inspiration and advice.

In the very early stage of project promotion the role of Knut Fylkesnes, through his involvement with the development of the National Universities' Programme on Development Research and Education (NUFU), was invaluable for facilitating institutional anchorage and funding. In this regard the late Magne Lerheim, the first NUFU Chairmen, also deserves acknowledgement for his positive attitude and role in securing project financing.

A very special mentions to Syed Modasser Ali my true Bengali «bai». His involvement, especially in those hectic first years of project promotion was indispensable. Our renewed contact the last year in relation to new project ideas has been especially exciting.

In London I am indebted to the encouragement and inspiration of Don Mclaren, pioneer in Vitamin A research and editor of the International Vitamin A Consultative Group newsletter. Darwin Minassian at the Epidemiology Unit gave the important initial support during the tenure at the International Centre for Eye Health and for his continuing positive encouragement throughout the project period. Emin Kureghian deserves a special mention for his contribution in the development of the database and to his friendship and continuing hospitality during the many stopovers in London.

I am grateful to Bjørn Thylefors of the World Health Organization for his contributions with the realisation of the Tromsø workshop.

A special appreciation goes to Olav Helge Førde whose support especially in the development phase of the project was crucial. Olav Helge has always been forthcoming whenever there was a need.

A special mention and thanks go to Hung Cheng whose contributions in the development of the corneal endothelium study and subsequently as Chairmen of the Academic Review Committee was extremely precious.

My appreciation also goes to David Apple, the «world guru» on intraocular lenses for his personal support in promoting the project through his contribution at the Tromsø workshop and later as member of the review committee.

In south Asia the local academic co-ordinators, and the regional office staff in Kathmandu all deserve appreciation. A special thanks to Mukti Gharti, the ever dependable field co-ordinator and subsequent regional office manager.

Hem Gurung the principal project administrator and multipurpose project booster, secured everything from the people management (for keeping the moral of all concerned with project work including the sometime wild and unmanageable project «academic» co-ordinator), the management of computer hardware and information databases and project funds. Hem's inputs were indispensable for the success of this project. He continues to lend his valuable contributions in Nepal as the Norwegian Embassy's liason officer in Kathmandu.

In Tromsø, I would like to thank the administrative staff of ISM with a special mention to Gerd Furumo and Johnny Bakkevold who saved me in the last minute administration of the submission of the thesis. Ruth Bjørn and Bjørg Hunstad were indispensable in the administrative and financial matters especially in the contact with the NUFU secretariat in Bergen and the link to the regional office in Kathmandu. Their visit to the project area in western Nepal where they showed a special appreciation to the local staff, is

one of the very fond memories from those early days of the project development.

I would also like to thank the Department of Ophthalmology and IKM for their understanding during my time as lecturer with a special appreciation to Erling Grønvold Olsen, Terje Christoffersen, Trond Flægstad and Eilif Nilssen.

Knut Schrøder was extremely helpful to facilitate the involvement of the Eye Department's Ophthalmic Photographer in the training of local technical staff. Gunn Alm took charge of this work and managed to bring out beautiful cell pictures after a special training session at Topcon's US Headquarters in New Jersey. This was a crucial input for the further training of the technical staff in Nepal and Bangladesh.

Appreciation goes to the Norwegian Research Foundation (NFR) for sponsoring my three years as a research fellow. I am especially thankful to Ellen Vollebæk at NFR who was always forthcoming when clarifications were needed in dealings with any financial or administrative matters.

I am greatly indebted to Frank Billson for his friendship, unwavering support and encouragement. A special mention also goes to Rajendra Pararajasegram who, with his valuable insight, has been a great colleague.

Ole Mjøs has from his opening remarks in his capacity as Rector at the first workshop in 1990, and later as Chairmen of NUFU, been a wonderful source of inspiration in the academic environment of Tromsø.

My supervisor Egil Arnesen was the stern but patient pilot steering the harnesses of the wild horse to bring the project to completion. His involvement can only be compared to the very special old pale cognac.

And finally Tone, Magnus and Anders have borne with me throughout and have taken the time to share the many wonderful experiences in Nepal, Norway and elsewhere. Without Tone's generosity and understanding this project would never have been realized. And at last I thank *the project* for Yuriko and my third son Simon.

LIST OF PAPERS

Paper 1
Snellingen T, Shrestha BR, Gharti M, Shrestha JK. Socio-economic barriers to cataract surgery in Nepal: The south Asian cataract management study. Br J Ophthalmol 1998;**82**:1424-8.

Paper 2
Snellingen T, Rao GN, Shrestha JK, Huq F, Cheng H. Quantative and morphological characteristics of the corneal endothelium in relation to age, sex, ethnicity in cataract populations of south Asia: The South Asian Cataract Management Study.

Paper 3
The South Asian Cataract Management Study Group. The south Asian cataract management study I. The first 662 cataract surgeries: a preliminary report. Br J Ophthalmol 1995;**79**:1029-35.

Paper 4
Snellingen T, Shrestha JK, Fazlul H, Husain R, Koirala S, Pokhrel RP, Kolstad A, Upadhyay MP, Rao GN. The south Asian cataract management study: complications, vision outcomes and corneal endothelium cell loss in a randomized multicenter clinical trial comparing intracapsular cataract extraction with and without anterior chamber intraocular lens.

1. BACKGROUND

In 1985 while working as a resident at the Eye Department of the University Hospital of Tromsø, Akhtar Hussain, then a low vision consultant, drew my attention and interest to the problem of world blindness and encouraged me to pursue the possibility of working in an eye care programme in the south Asian region. This led me to a three months mission with Dr Albert Kolstad at the Geta Eye Hospital, Far-western Nepal. Later that year, on the invitation Akthar's brother in law the late Deputy Director General of Health, Sheik Hyder Ali, we conducted a study to explore modalities for eye care service delivery in the remote riverine area of Bangladesh. This work led to a survey of the prevalence of blindness conducted in April 1989 in the Patuakhali District of south central Bangladesh [1]. Later that year a project concept for the delivery of eye care services for this area was formulated at the Centre for International Eye Health, University of London [2].

When visiting the different eye care projects in the region I was impressed seeing how cataract surgery of high quality could be maintained in systems with constrained resources. At that time all cataract surgery in Nepal, Bangladesh and India were performed with the Intracapsular Cataract Extraction and aphakic spectacle correction (ICCE-AG).

When addressing the issue of cataract blindness and its backlog (prevalence of unoperated cataract blind) it seemed that ICCE would still have a definite important role to play in the treatment of cataract blindness.

In 1989, during my tenure in London as a diploma student at the International Centre for Eye Health, the debate on the use of intraocular lenses (IOLs) in the developing countries was a major issue. The question raised, however, was not *how* but *when* IOLs should be introduced in this setting. At that time the technique of extracapsular cataract extraction (ECCE) was considered to be the only possible approach in IOL surgery.

By 1989 however, researchers in the US showed that a new generation of lenses were safe when combined with ICCE. The logical question was therefore:

Was the new generation of anterior chamber intraocular lenses combined with ICCE an alternative to ECCE lens surgery?

After discussions with staff of the Institute, visitors from the World Health Organization's Prevention of Blindness Programme (WHO/PBL), and colleagues from south Asia, it became clear that here was a research opportunity -and one that was urgently needed. This gave the impetus to the development of this project.

As the first step, I visited Professor David J. Apple at the Center of Intraocular Lens Research, US and discussed the issue of IOL. With his understanding and in further consultation with Dr. Bjørn Thylefors programme director, the WHO/PBL and Professor Olav Helge Førde, University of Tromsø an application for funds was submitted to the UN section of the Norwegian Ministry of Foreign Affairs for a small expert consultation to be hosted by the University of Tromsø in May 1990.

With the background data presented by Professor Apple at this consultation, I set out to mobilise resources for a regional study in south Asia focusing on the safety of the new generation of multiflex AC IOL with the traditional ICCE technique.

2. INTRODUCTION

2.1 Cataract blindness and its epidemiology

Cataract is the opacification of the crystalline lens of the eye and is related to the normal ageing process, age being the greatest risk factor for developing the disease [3]. Other risk factors include exposure to excessive ultraviolet radiation [4], severe dehydration [5], malnutrition, diabetes and other metabolic diseases [6]. To date no treatment of cataract blindness has been found except surgery.

Cataract as a blinding disease is prevalent in developing countries particularly in Africa south of Sahara [7] and south Asia [8].

While working with smallpox eradication in south Asia in the 1970s [9] epidemiologists were struck by the many blind people in the rural villages. These observations gave the impetus for the introduction of formal population sampling techniques in the study of the prevalence and distribution of blinding eye diseases [10]. Based on a sample of a cross section of the population the Nepal Blindness Survey found that 0.84% of the Nepali population were blind (visual acuity less than 3/60 better eye). 66% of all blindness was due to cataract. The highest prevalence of cataract blindness was found among women. In the age group of 65+ 21.5% males and 36.7% females were blind due to bilateral cataract [11,12].

Subsequent surveys have shown that in the developing countries of Asia including China, and parts of sub Saharan Africa, cataract is the most important cause of bilateral blindness ranging from 60%-90% in south Asia to 20%-50% in sub-Saharan Africa [13]. In the study conducted in the southern riverine area of Bangladesh we found age and sex adjusted rate of cataract blindness to vary from 5.6% in the age group 50-54 to over 23% in the age groups 65 and above [1]. Females were also here at greater risk of developing bilateral blinding cataract than men.

With the increasing life expectancy the incidence of cataract is on the increase. According to the UN global population estimates and projections it is expected that the age group 60 and above will double by year 2020 in the developing countries comprising 13.6% of the total population [14]. WHO estimates the backlog of cataract blind to 16 million cases. There are presently an estimated 7 million cataracts operated yearly. If the backlog is to be eliminated within the next 20 years 32 million cataract surgeries must be performed [15]. In India, despite a substantial increase in the number of cataract surgeries the last decades (from 0.5 million operations in 1981-82 to 2.2 million operations in 1994 -95) the prevalence of cataract blindness increased from 2.4 million in 1974 to 4.3 million in 1986 [16].

Even with the increase in the current number of cataract surgeries it will be a major task to eliminate the increasing backlog of cataract blindness in the developing regions e.g. Africa south of Sahara and south Asia.

2.2 Barriers to cataract surgery

Despite the efforts from health providers in creating awareness of the benefits of cataract surgery there still exists substantial barriers to seek the services. In 1981 Padmashree et al were the first who reported of the existence of such barriers in India. A follow-up study of 82 villagers with severe vision loss advised to have cataract surgery showed that only 14.3% had surgery. They found that there were both economic and social barriers to seek

the services [17]. More recent studies in Nepal and India have shown that awareness of the benefits of surgery tended to be found among male, literate and more affluent than those who were unaware of the operation [18,19]

2.3 The surgical treatment of cataract

The earliest authentic records of the treatment of cataract come from ancient Hindu medicine. The cataract was recognised as a opacity in the "eye apple" long before the acceptance of this view in Europe in the second half of the 18th century. Susruta in the wealth of his teaching in anatomy and surgery, described several varieties of cataract and the technique of its treatment by couching. The operation of *couching* or *reclination* was widely employed in India and has continued until the second half of this century. The first, however to make a planned extraction of a cataract from its natural position behind the iris was Jacques Daviel who made known his technique in 1748 inaugurating the first revolution in ophthalmic surgery.

2.3.1 Intracapsular Cataract Extraction

The techniques of intra- and extracapsular extraction were both practised from the turn of the 18th century. In the beginning of the 20th century the intracapsular method was popularised by Colonel Henry Smith on thousands of patients in India using a von Graeffe's surgical section followed by exprimation of the crystalline lens. Smith adopted the technique of Malronez of Amritsar who did the procedure by putting pressure on the globe with the assistance of a strabismus (squint) hook. This method has been extremely popular, particularly in India, and even today is being practised by many surgeons when performing ICCE. With the realisation of using traction instead of pressure (reducing vitreous complications) and with the development of a cryosurgical probe (freezing the crystalline lens to the instrument), from the late 1950's, ICCE was being widely adopted as the preferred surgery. Duke Elder when writing about ICCE states that «intracapsular surgery whereby the lens is extracted entire with its capsule leaving no remnants behind, is obviously the method of choice, but it has only recently become universally popular» [20].

Only three decades later (1986), when extracapsular cataract surgery emerged as the preferred surgery, George Weinstein, when writing about ICCE in Duane' s Clinical Ophthalmology [21], proclaims in the introduction of the technique that- «it is difficult to believe that the elegant procedure of intracapsular cataract extraction has been largely supplanted by the extracapsular method, but this is exactly what has happened».

2.3.2 Extracapsular Cataract Extraction and Phacoemulsification

With the advent of "modern" cataract surgery some 200 years ago both ECCE and ICCE were practised with varying success. It was not until the introduction of microsurgical techniques in the latter part of the 1970s that ECCE became an accepted alternative to ICCE surgery. The ECCE surgery was soon to be followed by the technique of phacoe-mulsification.

In ECCE surgery the lens nucleus is delivered through the surgical wound after opening of the anterior lens capsule which is subsequently removed. In Phaco surgery the lens nucleus is emulsified within the eye and the lens matter is aspirated using an automated phacomachine. In both procedures a posterior chamber intraocular lens (PC-IOL) is then implanted in the

capsular bag. In uncomplicated surgery the posterior capsule remains intact.

2.4 Complications to cataract surgery

With surgical opening of the eye there is always a risk of infection. In addition, there are complications related directly to the surgical trauma. The complications to surgery may ultimately reduce visual function either through the opacification of the media, damage to the optic nerve (secondary glaucoma), detachment of the sensory macula-retina (retinal detachment) or pathological processes in the macula (cystoide macular edema) [22] .

In cataract surgery, in addition to the general complications of intraocular surgery, the eye is also exposed to complications related to the specific surgical procedure. In both ICCE and ECCE/Phaco surgery there is the risk of autoimmun inflammatory reactions due to the persistence of lens cortical remnants. Posterior segment complications include retinal detachment and cystoide macular edema. In ECCE surgery there is also a risk of post-operative posterior capsular opacification (PCO) [23]. The post-operative treatment of PCO increases the risk of retinal detachment [24].

Complications to the IOL include physical irritation/trauma related to the implantation of the lens or to a post-operative dislocation. There is also an increased risk of acute septic [25] or chronic aseptic inflammation [26]. All these complications can lead to corneal decompensation, secondary glaucoma and cystoide macula edema. With the new generation of lenses, complications related to the IOL are infrequent.

2.5 Visual rehabilitation and intraocular lenses

Spectacle correction was until the latter part of this century the only practical alternative of correcting surgical aphakia (an eye without its crystalline lens). Significant dioptric power resides in the crystalline lens of the eye. Its removal, without some form of optical correction results in a significant visual impairment and disability [27-28]. Aphakic spectacle correction gives a «Gallilean telescopic effect» magnifying the world by an additional one third and thereby drastically altering depth perception. In addition lines viewed away from the optical centre of the lens appear curved, an effect exaggerated by movement reproducing what can be seen in a carnival fun house mirror. On top of these optical distortions there is the appearance of a ring scotoma (shadow) called *"Jack in the Box"* phenomenon, in which objects suddenly appear in the field of view from the side (blind area between the edge of the lens and the uncorrected visual field).
Apart from the contact lens, aphakic correction had changed very little in hundreds of years. It was not until the late 1940s that a clear understanding of the tremendous optical advantages that an intraocular lens (IOL) could provide in visual rehabilitation. The practical application of the concepts of IOLs began with the British ophthalmologist Dr. Harold Ridley and the credit for the introduction of IOLs belong to him. He felt compelled to develop his artificial lens when a medical student observed a cataract operation and conveyed his disappointment to Ridley that what was removed was not replaced in anyway. Ridley's observation of eyes of Spitfire Pilots with intraocular foreign bodies from the cockpit plexiglass canopy showed that unless a sharp edge of the plastic material rested in contact with a sensitive and mobile portion of the eye the tissue reaction was insignificant. This led him to believe that plexiglas if properly

polished, could be well tolerated inside the eye.

It is important to underline that for more than 30 years the use of IOLs was experimental. A wide variety of lenses were used with both the intracapsular and extracapsular techniques. No formal studies on the safety of IOLs had been carried out and there were no regulations concerning the quality. Despite the lack of data concerning safety of IOL surgery, by the middle part of 1970s, lenses were manufactured and marketed by the industry for routine use. It became clear by the early 1980s that an increasing number of long term surgical complications were related to IOLs. However until the end of the decade, sufficient data was not available to give a proper analysis of the pathological determinants of the complications of IOL surgery. The evolution of IOLs are described in detail by David Apple in his work on IOLs [22].

2.6 The Corneal endothelium and cataract surgery

The corneal endothelium is a monolayer of primarily hexagonal cells lining the posterior part of the cornea or anterior border of the eye's anterior chamber. Each cell has an average diameter of 100 micron. The corneal endothelium is essential for the maintenance of normal corneal hydration, thickness, and transparency [29]. Vogt, in 1918 [30], showed that it was possible with the slitlamp microscope to visualise the endothelial mosaic in the axis of a reflected light beam. In 1968, a microscope with appropriate magnification was designed by Maurice. From 1975 [31-32] numerous studies using small and wide field specular microscopy have described the normal and post-operative human corneal endothelium. With the realisation of the possible damaging effects of IOL surgery on the corneal endothelium the use of specular microscopy became an important tool in the pre and post-operative surgical evaluation [32]. Due to the difficulty in the routine use of corneal specular microscopes it was not until the introduction of digital imaging with high capacity storage systems that specular microscopy could be used in more routine clinical work. By then however, due to the improvement of IOL technology, the complications of IOL were significantly reduced. The interest for specular microscopy in connection with IOL surgery virtually disappeared. The inclusion of specular microscopy in this study was based on the work of Bates et al who showed that corneal endothelium cell loss is an important predictor for post-operative corneal decompensation after IOL surgery [33-34]. In our study specular microscopy was included to give the basis for predicting long term corneal survival. This was important as there were no available longitudinal data on corneal cell survival with the new anterior chamber lens (AC IOLs). Some of the older anterior chamber lenses were related to clinically significant corneal endothelial cell loss resulting in corneal decompensation within the first five years after surgery [35-36].

2.7 Intracapsular cataract extraction vs. extracapsular cataract extraction and intraocular lenses: operations research considerations

IOLs have been in clinical use since the early 1950s and from the mid 1970s the promulgation of IOL surgery increased rapidly. It was however, not until the beginning of the 1980s that an attempt was made to compare different surgical procedures using a scientific study design [37-38]. The Oxford Cataract Treatment and Evaluation Study Team (OCTET) gave important methodological bench marks for the conduct of clinical outcome studies of cataract surgery.

It was early on quite clear that IOL surgery gave better visual rehabilitation for the patient. Due to the increased complexity of the surgery there was, however, an active debate on how and when such an initiative should be made in developing countries [39-42]. In the developed countries the majority of surgeons were performing the ECCE technique combined with implanation of a posterior chamber lens. In developing countries the ICCE technique was the primary surgery in most settings.

By the end of the 1980s many surgeons had started performing ECCE PC IOL surgery in the developing countries and several IOL manufacturers were established. In India by the middle of the 1990s, 50% of cataract surgery was ECCE surgery [43].

The flawed lens design and inadequate manufacturing techniques from the late 1970s related primarily to ICCE AC IOL surgery has undoubtedly been a contributing factor to the rapid conversion to ECCE the last decades [44]. By the end of the 1980s, however, it was clear that the new multiflex anterior chamber intraocular lenses were safe in use for both primary and complicated secondary surgery [45-46]. The complications of pseudophakic bullous keratopathy seen with the use of the older AC IOLs was clearly not an issue with the new multiflex AC IOLs.

In December 1990 the World Health Organization's Prevention of Blindness Programme convened a expert consultation on the use of IOLs in developing countries. The main techniques of cataract surgery were reviewed. It was concluded that the ICCE technique had several advantages to the ECCE technique (table 1). If the ICCE technique could safely be combined with a IOL the problems of aphakia (ICCE-AG) would be overcome. This could give ICCE surgery a potentially important role in the reduction of the cataract backlog. It was therefore recommended that larger randomised studies should be conducted in the developing countries comparing the two techniques of cataract surgery with and without IOL implantation [47].

3. AIMS AND OBJECTIVES OF THE STUDY

The aim of this study was to compare clinical outcomes of ICCE surgery with and without AC IOL implantation.

3.1 General objectives

The South Asian Cataract Management Study was funded by the Norwegian Universities' Council for Development Research and Education (NUFU). NUFU is government sponsored programme with the aim to develop capacity and competence in academic research in partner institutions: In accordance the project had as its general objectives:

1) to develop local competence and capacity to undertake scientific evaluation of surgical interventions.

2) to demonstrate the value of regional network projects as important tools when developing policy frameworks for programme strategies to combat cataract blindness .

3.2 Specific objectives:

to compare of intracapsular cataract surgery with and without lens implantation in relation to three main outcomes:

1) vision
2) complications
3) corneal endothelium cell survival

4. SUBJECTS AND METHODS

The thesis is based on data from a multicentre randomised clinical trial carried out in three countries of the south Asian region. Nepal: the Rapti Eye Hospital, Dang District; Bangladesh: the Institute of Community Ophthalmology, Chittagong, Bangladesh; India: the L.V. Prasad Eye Institute, Hyderabad, Andhra Pradesh. A co-ordinating centre was established at the Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu (Map).

After a 3 month training phase the inclusion of patients was conducted between January 1993 and December 1995. Patient follow-up continued until April 1998.

4.1 Participating centres and recruitment of cases

The participating centres represents different clinical facilities south Asia.

Centre 1

Rapti Eye Hospital, Dang District , Nepal.

Rapti eye hospital is a small eye hospital located in a rural farming region of mid-western Nepal. The hospital is part of the non governmental national (NGO) network of eye hospitals. The work is mainly focused on cataract surgery (in patient) and seasonal corneal infections (out patient). Approximately 600 cataract operations are done yearly. 48% of the study patients were recruited through specially conducted screening camps for this project (Paper I). The remaining patients were recruited from the outpatient clinics of the eye hospital.

Centre 2
Institute of Community Ophthalmology, Chittagong University and Eye Infirmary and Training Complex, Bangladesh.

Centre 2 is a national and regional NGO training centre for doctors, nurses and paramedics and the apex institution for the Bangladesh National Society for the Blind's nine base eye hospitals. The centre has more than 120 000 visits per year. Over 4000 (ICCE and ECCE) cataract operations are performed in the centre and over 1000 (ICCE) operations are performed in mobile eye camps. The study cases were recruited both from eye camps and from the outpatient clinic.

Centre 3
L.V. Prasad Eye Institute Hyderabad, Andra Pradesh, India

Centre 3 is a non-profit private clinical and research centre with all sub specialities including corneal transplantion. The centre performs approximately 6000 (ECCE-PC IOL) cataract operations per year. No routine ICCE surgery is performed. All patients were recruited from the outpatient clinics.

Regional Office, Institute of medicine, Tribhuvan University

The Institute of Medicine hosted the regional co-ordinating office for the project. Located at the at the Tribhuvan University Teaching Hospital, Kathmandu. The office was responsible for the daily co-ordination in relation to overall logistics support and financial matters.

4.2 The study population

The study population consist of three different ethnic populations of south Asia: south Indian of Andhra Pradesh, the Nepali indigenous «Tharu» population of mid-western Nepal and a south Bengal

population of the Chittagong district of Bangladesh.

Patients between 40-75 years of age with cataract identified as the main cause of visual impairment were included in the study. One eyed patients and patients with debilitating disease were excluded (Papers III, IV).

The population consisted predominantly of rural farmers in centre 1 while centre 2 and 3 was a mix of urban and rural population.

Paper I

The subjects were screened as part of the recruitment project to the main study (figure 2). The study population includes male and female residents of Dang valley that fit the inclusion criteria of the main study but did not accept surgery within one year of the screening procedure. Of 168 non acceptors 96 were interviewed for this study.

Paper II

Presents an analysis of the central corneal endothelial cell in a total of 1235 (99.8%) preoperative eyes. A precision study testing sampling errors within and between observers was undertaken to evaluate the accuracy of the procedure.
10 post-operative study eyes and their controlateral non operated eye (pair) and 10 non operated pre-operative eyes of cataract patients not included in the study were examined.

Paper III- IV

Of the 1237 patients assigned randomisation 46.3% were blind (less than 3/60 better eye with best possible correction). 85.3% of inclusion eyes had a visual acuity less than 3/60 (best possible correction). There was no significant difference in mean age of study population between sexes or between the participating centres (p=0.26). There were no difference in the distribution of levels of vision of the inclusion eye between study groups (p=0.8).

4.3 Registration of data and Documentation of study findings

A database was developed on Paradox 3.5. The protocol included proforma cards for preoperative, intraoperative and postoperative schedules (Appendix). A monitoring system for patient follow up was included to facilitate the tracking of patients at different schedules.

Each patient was photographed with a Polaroid miniportrait camera. One photograph was attached to patient's folder and one photograph to patient study ID card.

The IMAGEnet© Digital Imaging System was used for photo-documentation of anterior segment and the central corneal endothelium. Corneal endothelial cell images were analysed using a semi-automated analysis technique (Paper II).

To ensure standardised methods of examination a dedicated manual of operations was developed for the technical staff of the project.

Intraocular pressures were taken with calibrated Goldmann© Applanation Tonometer. Schiøtz tonometer was used on the 30 patients examined in the field.

For examination of posterior segment rechargeable Heine© Ophthalmoscopes were used.

Post-operative testing of visual acuity was performed with Snellen type charts on both eyes at two levels:

1. Patient's Available Correction: IOL Group: No correction No IOL Group: +10 spherical correction
2. Patient's Best Possible Correction for both study groups with best spherical and cylindrical correction

4.4 Study monitoring and review

The academic co-ordinator made visits twice a year throughout the duration of the study and monitored study progress with a systematic review of patient's photo-documentation. Based on this review and periodic analysis of study data, the Study Review Committee met at three occasions during the study (1995,1997,1998).

5. MAIN RESULTS

5.1 Paper I:

Socio-economic barriers to cataract surgery in Nepal: the south Asian cataract management study [48].

Of 319 cataract patients identified for cataract surgery in the screening of a rural valley of mid-western Nepal 45.5% accepted surgery. Males accepting surgery more readily than females (RR=1.31; p=0.027). Of 96 non acceptors interviewed one year after the screening procedure only a further 13% accepted surgery after a second counselling. The most frequent reasons given for not accepting surgery were economic (48%) and logistical (44.8%) constraints followed by fear of surgery (33.3%) and lack of time (18.8%). Half of the subjects complained of problems with self care but only10% needed help for their most basic every day activities. 17.7% said they needed help to visit neighbours and 26% needed help to attend the field or market.

5.2 Paper II:

Quantitative and morphological characteristics of the normal corneal endothelium: The South Asian Cataract Management Study [49].

Table 2 presents the analysis of variance of multiple examinations of the precision study. We found a adequate precision of the technique used. The precision of cell density counts was 96%, for cell size variability-85% and for cell hexagonality 75%.

Significant differences were found between centres in central corneal endothelial cell densities, cell size variability and hexagonality. Females had a higher cell density than males. No significant difference was found in cell density by age in males or females. Variability of cell size, however, significantly increased with age. These findings were consistent across the three participating centres. Although there was a clear increase in range of number of six sided cells in both males and females there was no significant change in the mean number of six sided cells with increasing age.

5.3 Paper III and IV:

A total of 1229 patients were operated. Figure 2 presents the flow of patients. Paper III includes the first 662 cases included in the study with preoperative, surgical data and immediate short term data (6 weeks). Paper IV includes the complete data of pre-operative, intra-operative, immediate short term (6 weeks) and the long term follow-up.

Follow-up

Of the 1229 patients that underwent surgery 80 (6.5%) patients were dead before the last examination. 1040 (84.6%) were available for a final examination. The mean time of a clinical follow-up after surgery was 759 (sd=184) days: IOL =777 (sd=186), No IOL=742 (sd=180). Of patients lost to long term follow-up 152 (80.4%) had been examined at 6 weeks follow-up. 96.7% of these patients had a best corrected visual acuity of better than or equal to 6/60 in the operated eye (IOL=96.1%; NoIOL=97.2%). The characteristics of these patients are described in article IV.

Paper III:
THE SOUTH ASIAN CATARACT MANAGEMENT STUDY. The first 662 cataract surgeries: A preliminary report. The South Asian Cataract Management Study Group [50].

An analysis of the first 662 cataract surgeries which included 54.1% of the total study population found a intra-operative complication rate of 15.6% (IOL=16.9%, No IOL=14.1%, p=0.37). The most frequent complication observed was vitreous loss followed by plain capsular rupture, unplanned ECCE and iris dialysis. Mean corneal endothelial cell loss 6 weeks after surgery was 17.2% (SD=13.1%) in the total study population (IOL=18.5% NoIOL=16.1%, p=0.05).

The immediate post-operative complications rates (until 6 weeks follow-up) were significantly higher in the IOL group (IOL=6.9%, No IOL=2.6%, p=0.02), mainly due to mild to moderate iritis needing prolonged use of steroids. 89% of the patients had a best corrected visual acuity of 6/18 or better. There was no significant difference in visual outcome between study groups.

Paper IV:
The South Asian Cataract Management Study: Complications, Vision Outcomes and Corneal Endothelium Cell Survival in a Randomised Multicenter Clinical Trial Comparing Intrcapasular Cataract Extraction With and Without Anterior Chamber Intraocular Lens [51].

In 1229 surgeries we found a complication rate of 14.3%. There was no significant difference between study groups. 3.3% of cases needed a post-operative surgical intervention. IOL cases had an increased risk of secondary surgery (RR=2.32: 95%CI=1.19-4.52). The most frequent complication observed was vitreous loss followed by, macular edema.

Of the 1040 (84.6%) patients that had completed the clinical follow-up a "functional" vision (patient's available correction) of 6/60 or better was found in 899 (86.4%) patients (IOL=83.0%; NO IOL=90.3%).

With the best possible correction 96.3% had a visual acuity better or equal to 6/60 and 87.7% had a visual acuity better or equal to 6/18 (best corrected vision). In the overall study population there was no significant difference in the distribution of levels of best corrected vision between study groups (IOL=88.8%; No IOL=86.6%).

Retinal detachment was the most frequent major long term complication occurring in 6 (0.6%) eyes. There were two cases of secondary glaucoma (both in the No IOL group) and one case of corneal decompensation (due to displacement of lens between 6 weeks and 24 months).

At the 6 week postoperative follow-up the surgically related central corneal endothelial cell loss was 15.8% (sd=13.0). There was a 2.7% greater cell loss in the IOL group compared to the No IOL group (p=0.0005).

During the two year follow-up period there was a 7.4% overall continuing cell loss. 8.2% in the IOL group and 6.5% in the NO IOL group (p=0.03). From 12 months to 24 months after surgery we found no statistical difference between centres or study groups.

6. DISCUSSION

6.1 Considerations of study design

6.1.1 Study population

The characteristics of patients both in relation to age and maturity of cataracts can influence complications rates in cataract surgery [52]. In this study population, which included three different ethnic groups (reflected in the geographical differences of pre-operative central corneal endothelial cell characteristics) (Paper II), we found no differences in the age and sex distribution between study groups. There was also a similar distribution in levels of pre-operative vision (reflects the maturity of cataract that may influence the rate of intra-operative surgical complications). 85.1% and 86.6% of pre-operative eyes in patients assigned to IOL and NO IOL respectively were blind (<3/60).

6.1.2 Surgery

The most important determinant for the outcome of cataract surgery is the quality of the surgical procedure. This is reflected in the wide variability of intra-operative surgical complications that are reported in the literature [53]. This study includes three clinical centres with different surgical facilities from low cost type of technology to sophisticated technology (phaco and automated vitrector machines).

A total of 19 surgeons participated in the study. Most surgeons, although experienced in ICCE technique, had implanted only a few AC IOLs before entering the study. Centre 3 was not performing ICCE routinely at the start of the study. This centre had both the highest the rate of intraoperative surgical complications and the greatest variability in complication per surgeon. The routines for handling surgical complications was standardised within centres. In centre 3 rupture of the anterior vitreous face was always followed by anterior vitrectomy using a automated (cutting) vitrector machine. In centres 1 and 2 the anterior vitrectomy was performed with the sponge technique. There were no significant differences in the rate of intra-operative surgical complications between study groups. Even though the IOL cases had, a significant higher risk of reoperation than the no IOL group, the absolute risk was small.

6.1.3 Follow-up

Patient follow-up in this study varied between the three centres. This was mainly due to the differences in relation to location of the participating centres. The map shows the location of the centres and approximate field area for patient tracking. Follow-up was best in the rural centre (over 90%) while the centres located in the large urban areas (Chittagong and Hyderabad) had greater difficulties to track the patients.

The study was designed to have a 90% probability to detect a difference between good and poor outcome of best corrected visual acuity at the 5% level with a risk ratio of 2 between study groups. Of the 1237 patients included in the study, excluding the 8 patients not having undergone surgery, 1040 (84.7%) were available for long term follow-up (12 and

24 months). Based on the original assumptions our end point data gives us a 80% probability of detecting differences between groups. For both the total study population and at centre level we found no statistical differences between study groups. There were no significant differences between patients examined and lost to follow-up in sex, mean age, pre-operative mean corneal endothelial cell density or surgical complications. In the IOL group we found a marginal but statistically significant difference in the distribution of best corrected vision between patients examined and not examined (p=0.008).

6.2 Study findings

6.2.1 Vision outcomes

Despite a significantly greater number of surgeons and variabilty in the frequency of surgical complications our study found highly comparable clinical outcomes with a similar randomized study that included only two surgeons with a significantly lower frequency low frequency of surgical complications than what was found in the SACMS.

In the Lahan Intraocular Lens Study comparing ICCE-AG and ICCE AC-IOL (LIS study) [54] 90% of IOL group had «normal» vision (better or equal to 6/18) compared to 89% in the SACMS. In the No IOL group however th difference was greater (LIS study=93%; SACMS=88%).

The «functional» vision is difficult to compare due to different routines of IOL power calculation and different defintions of postoperative vision.

"Functional" vision in the SACMS represents a comparison of the standard +10 spectacle correction normally given after eye camp surgery and the pseudophakic correction of IOL.

49% had a normal vision in the IOL group compared to to 54% in the No IOL group (p=0.04). In centre 1 the power of IOL was made without the use of biometric measurement. In all three centers the IOL group did better than the No IOL group while center 1 the IOL group did significantly better than in the other two centers. 76% had normal post-operative vision (no additional correction) compared to 36% and 45% respectively.
The other centres performed a power calculation based on biometric measurements. The patients in these centres received a wider range of IOLs (15.0-23.0). Here there were highly significant differences between study groups with the IOL group doing poorer than the No IOL group (p=0.7).

6.2.2 Long term postoperative complications

a) Anterior segment
Cataract surgery with implantation of anterior chamber lens has historically been related to severe anterior segment complications such as corneal decompensation (pseudophakic bullous keratopathy) and secondary glaucoma.
The Madurai Intraocular Lens Study (MIOLS) [55,56], the LIS and SACMS have all shown that the use of modern intraocular lenses, both PC IOL and AC IOL, is safe. In 1534 surgeries with a follow-up of one year or more (SACMS and LIS), one corneal decompensation was related to the IOL (0.07%). This was due to dislocation of lens after assumed trauma to the eye during the follow-up period. In 429 (70%) eyes with AC IOL followed for two years after surgery continuing cell loss did not increase significantly compared to ICCE patients without IOL implantation.

a) Posterior segment

Cystoide macular edema (CME) and retinal detachment (RD) are the two complications of the posterior segment related to cataract surgery. Both CME and RD have been reported to vary widely (53). Angiographically verified CME has shown to vary between 2.7%-11.3%. in ECCE surgery. The MIOLS study, designed to detect differences in CME between ICCE and ECCE surgery, showed a clinically significant difference in CME between ICCE-AG and ECCE PC IOL surgery (ICCE-AG=4.2%; ECCE-PCIOL=1.6%). Unfortunately they did not include a ICCE with IOL group.

In the LIS study, in those with poor vision (<6/60), although not confirmed with fluorescein angiography, reported a frequency of CME of 0.5% in both study groups (ICCE-AG and ICCE-AC-IOL). Our study was not designed to confirm this diagnosis. We found clinically suspected macular edema in three cases (0.3%) at the final examination that reduced vision to less than 6/60. Vogel et al reported in their randomised study a clinical significant frequency of CME of 4.5% in ICCE AC IOL surgery (177 cases) [57] while Williamson reports a frequency of CME of 0.5% (vision less than 20/50) in 200 cases of ICCE-AC IOL [58].

RD has shown to vary between 0.5-2%. In our study we found that by two years after surgery 0.6% (IOL=0.4%; No IOL=0.8%) had RD. This is consistent with what has been reported in the LIS study. The MIOLS comparing ICCE and ECCE PC IOL found RD in 0.4% in the ICCE-AG group and 0.2% in the ICCE-PCIOL. The difference was not statistically significant.

6.2.3 Corneal Survival

Our study of pre-operative corneal endothelium has revealed that there exists quantitative and morphological differences between sexes and between ethnic groups.

Based on our stratified analysis of pre-operative eyes we found that from the fourth decade, although there is a continues increase in the variation of central corneal endothelial cell size, there is no significant differences in central corneal endothelial cell density between age groups (Paper II).

The significant continuing cell loss found after cataract surgery is related to the surgery itself. Increased corneal endothelial cell loss with resulting corneal decompensation was related to poorly designed and polished lenses either through direct trauma to the corneal endothelium or secondary to low grade uveitis due to the rubbing of poorly polished IOL surface against the iris tissue. Bates and Cheng in their study of a subgroup of IOL surgeries found that IOL related decompensations were manifested clinically by the second year after surgery [59]. After five years 1% of the corneas decompensated. All these eyes showed a significantly greater cell loss compared to the eyes without decompensation already at the 6 month post-operative exam. In our study we found a small but significant difference between study groups at 6 weeks after surgery. Between 6 weeks and two years of follow-up there was a small but significant continuing cell loss in one centre. Between 12 and 24 months there was no significantly continuing cell loss at centre level or in the overall study population. We are therefore confident that, based on these data and data from the previous studies described above, we would not expect the development of pseudodophakic corneal complications related to the intraocular lens.

6.2.4 Barriers to seek cataract surgery

Although we find a variation in physiography, ethnicity and socio-

economic conditions between districts and regions , from our interview of patients who did not accept surgery (paper I), we see that barriers to cataract surgery that have previously been described in past studies still exist in Nepal.

In Bangladesh, as in Nepal, the access to eye care services has improved with the development of private non profit charitable eye hospitals throughout the country. The access to these hospitals is better than in Nepal. To our knowledge no studies have been undertaken on surgical coverage in Bangladesh.

In India the socio-economic variables and access and permanence of services varies greatly both between states and within states. These factors will be the most important determinants for future awareness and subsequent interest to seek services. The utilisation of eye care services will certainly increase with the continuing socio-economic development in this region. The big challenge will be however to secure a equitable distribution. How to keep qualified manpower in the districts is a major concern. Currently over 50% of ophthalmologists are residing in capital cities of Nepal and Bangladesh. The choise of surgery (ICCE vs ECCE) and the use of para medical manpower for performing cataract surgery will undoubtedly be a major issue in this context.

7. MAIN CONCLUSIONS AND IMPLICATIONS OF INTERVENTION STUDY

Conclusions

- Intracapsular cataract extraction with implantation of an anterior chamber intraocular lens does not significantly increase the risk of major sight compromising long term complications compared to intracapsular cataract extraction without implantation of AC IOL.

- Stratified analysis of preoperative cataract eyes shows no evidence of a significant loss of corneal endothelial cell density in non operated eyes with age above 40 .

- Our longitudinal data shows corneal endothelial cell loss in eyes after intracapsular cataract extraction both with and without implantation of IOL.

- We found no evidence of a significantly greater long term post-operative cell loss in the eyes with implanation of AC IOL compared to eyes without implantation of IOL.

Implications

- ICCE AC IOL surgery should be considered as an alternative to ECCE-PCIOL when introducing IOL especially in clinical centres with constrained resources and in eye camp surgery. It is a procedure well adapted to high volume catarct surgery for both medical and paramedical surgical manpower.

- A re-evaluation of the training of ophthalmologist is needed so the skill of ICCE surgery is not lost in the coming generations [60-61].

8. FURTHER RESEARCH NEEDS

- Follow-up of study population

Further analysis 5 years after surgery of subsample of eyes with pre- and postoperative low cell counts (preoperative < than 2000 cells mm^2) and postoperative

< than 1500 cells mm^2) would give a more definite picture of patients with potentially vulnerable corneal endothelium.

- Population based studies of cataract outcomes

As the data is accumulating from the clinical trials we need to go beyond these studies as these primarily reflect the best possible scenarios or the «gold standard» of cataract surgery. To really assess the issue of risk/benefit, population based studies and rapid assessment of cataract outcomes in the population need to be made. These will reflect the real situation when many surgeons are operating in different environments with differing techniques.

Studies, that includes patients examined up to 10 years after surgery are now becoming available and are reporting very different outcomes than what has been reported in the prospective controlled trials (table 3). From the XVI Congress of Asian Pacific acdemy of Ophthalmology (APAO) data from population based studies from Nepal and China (1995-1996) showed a high percentage of patients with poor vision outcomes [62-65]. 31-42% of patients examined had a presenting vision less than 6/60 (severe visual impairment and blind) (table 3). The population data presented did not give basis to compare ICCE and ECCE.

- Assessment of outcomes of ECCE surgery in eye camps of Nepal

The XVI APAO Congress also presented data from the results of eye camp surgery in Nepal. The only study to present patients with long term outcomes showed alarming results [65]. 166 eyes of 166 patients with ECCE surgery in eye camps in eastern Nepal were examined within 32 months after the operation. Only 41.5 % had a functional presenting vision of v.a. 6/60 or better and 58% were severely visually impaired. 18.4% of the patients had no improvement of vision and 20.8% had poorer post-operative than pre-operative vision. 20 % had clinically significant posterior capsular opacification and many of the eyes had problems with retained cortical lens matter.

Centres in India are now training surgeons in ECCE but often without access to Yag laser or even IOLs. A survey questionnaire published in the Indian Journal Ophthalmology showed that 20% of cataract surgery in India is done with ECCE without implantation of a IOL [43]. These patients will surely have a great risk of posterior capsular opacification.

As an increasing number of patients are coming forward to have cataract surgery with increasing levels of better pre-operative vision (better than 6/60 and even 6/36) the most crucial issue will be whether monitoring and surveillance systems will be sufficiently developed to give the needed feed back of the quality of services in terms of short and long term vision outcomes in the background of a rapidly evolving high tech cataract surgical procedure. These systems, will ultimately be the judge of whether one or the other surgery is the best for a setting taking into account the local burden of cataract blindness and the available resources.

9. REFERENCES

[1] Snellingen T. prevalence of blindness in the rriverine districts of south central Bangladesh and strategies for its prevention (Masters of Public Health 1989 - Unpublished).

[2] Snellingen et al. Joint Project at the International Centre for Eye Health. 5 year development programme for a comprehensive eye care delivery system for the riverine south-central bangladesh:. Diploma Course 1989.

[3] Hodge WG, Whitcher JP, Satariano W. Risk factors for age-related cataracts. Epidemiol Rev 1995;**17**:336-46.

[4] Taylor HR, West SK, Renthal FS. Effect of ultraviolet radiation on cataract formation. N Engl J Med 1988;**319**:1429-33.

[5] Minassian DC, Mehra V, Verrey JD. Dehydrational crisis: a major risk factor in blinding cataract. Br J Ophthalmol 1989;**73**:100-5.

[6] Harding JJ, Heyningen R van. Epidemiology and risk factors of cataract. Eye 1987;**1**:537-41.

[7] Foster A. Who will operate on Africa's 3 million curably blind people? Lancet 1991;**337**:1267-9.

[8] Minassian DC, Mehra V. 3.8 Million blinded by cataract each year: projections from the first epidemiological study of the incidence of cataract blindness in India. Br J Opthalmol 1990;**74**:341-3.

[9] Fenner F, Henderson DA, Arita I, Jezec Z, Ladnui ID. Smallpox and its eradication. World Health Organization, Geneva, 1988: 711-48.

[10] Methods of assessment of avoidable blindness. WHO offset publication 1980 No 54. World Health Organization Geneva.

[11] The Epidemiology of Blindness in Nepal: Report of the 1981 Nepal Blindness Survey. 1988 Seva Foundation.

[12] Brilliant LB, Pokhrel RP, Grasset NC, Lepkowski M, Kolstad A, Hawks W, Pararajasegaram R, Brilliant GE, Gilbert S, Shrestha SR, Kuo J. Epidemiology of blindness in Nepal. Bull World Health Organization 1985;**63**:375-86.

[13] Thylefors B, Negrel AD, Pararajasegaram R, Dadzie KY. Globaldata on blindness. Bull World Health Organ 1995;**73**:115-21.

[14] 1996 UN Global Population Estimates. UN Population Division 1997 report.

[15] Thylefors B. A global initiative for the elimination of avoidable blindness. Editorial. Am J Ophthalmol 1998;**125**:90-3.

[16] Limburg H, Kumar R, Bachani D. Monitoring and evaluating cataract intervention in India. Br J Ophthalmol 1996;**80**:951-5.

[17] Padmashree G, Wenkataswamy MS, Brilliant GE. Social and economic barriers to cataract surgery in rural south India: A preliminary report. Vis Imp Blindness 1981:405-8.

[18] Brilliant GE, Brilliant LB. Using social epidemiology to understand who stays blind and who gets operated for cataract in a rural setting. Soc Sci Med 1985;**21**:553-8.

[19] Brilliant GE, Lepkowski MJ, Zurita B, Thulasiraj RD. Social determinants of cataract surgery utilisation in south India. Arch Ophthalmol 1991;**109**: 584-8.

[20] Elder D. Systems of Ophthalmology. Henry Kimpton 1965;**11**:248-63.

[21] Duane T. Textbook of Ophthalmology Lippincot 1986; **6**:25.

[22] Apple DH, Mamalis N, Olson RJ, Kincaid MC. Intraocular lenses: Evolution, Designs, complications, and pathology. 1989 Williams & Wilkins pp. 225-361.

[23] Apple DJ, Solomon KD, Tetz MR, Assia EI, Holland EY, Legler UFC, Tsai JC, Castaneda VE, et al. Major review: Posterior capsule opacification. Surv Ophthalmol 1992; 37:73-116.

[24] Javitt JC, Tielch JM, Canner JK, Kolb MM, Sommer A, Steinberg EP. National outcomes of cataract extraction. Increased risk of retinal complications associated with Nd:YAG Laser caposulotomy. Ophthalmology 1992;99:1487-98.

[25] Javitt JC, Vitake S, Canner JK, Street DB, Krakauer H, McBean M, Sommer A. National outcomes of cataract extraction. Endophthalmitis following inpatient surgery. Arch Ophthalmol 1991;109:1085-9.

[26] Wenkel H, Runnelt V, Knorr H, Naumann GOH. Chronic postoperative endophthalmitis following cataract extraction and intraocular lens implantation. Germ J Ophthalmol 1993;2:419-25.

[27] Linksz A. Aniseikonia; with notes on the Jackson -Lancaster controversy. The XV Jackson memorial lecture. Am J Ophthalmol 1959;48:441-62.

[28] Woods AC. The adjustment to aphakia. Editorial. Br J Ophthalmol 1963;55:1268-72.

[29] Waring OW II, Bourne WM, Edelhauser HF, Kenyon KR. The corneal Endothelium: Normal and pathological structure and function. Ophthalmology 1992;89:531-90.

[30] American Academy of Ophthalmology. Corneal Endothelial Photography: Three year revision. Ophthalmology 1997;104:1360-5.

[31] Laing RA, Sandstrom MM, Leibowitz HM. In vivo photomicrography of the corneal endothelium. Arch Ophthalmol 1975;93:143-45.

[32] Bourne WM, Kaufman HE. Specular microscopy of human corneal endothelium in vivo. Am J Ophthalmol 1976;81:319-23.

[33] Bates AK, Cheng H, Hiorns RW, Pseudophakic bullous keratopathy: relationship with endothelial cell density and use of predictive cell density and use of a predictive cell loss model: a preliminary report. Cur Eye Res 1986;5:363-6.

[34] Bates AK, Hiorns RW, Cheng H. Modelling of changes in the corneal endothelium after cataract surgery and penetrating keratoplasty. Br J Ophthalmol 1992;76:32-5.

[35] Apple DJ, Brems RN, Park RB, Norman DK, Hansen SO, Tetz MR, Richards SC, Letchinger SD. Anterior chamber lenses. Part I: Complications and pathology and a review of designs. J Cataract Refract Surg 1987;13:1257-74.

[36] Apple DJ, Hansen SO, Richards SC, Ellis GW, Kavka-Van-Norman D, Tetz MR, Pfeffer BR, Park RB, Crandall AS, Olson RJ. Anterior chamber lenses. Part II: A laboratory study. J Cataract Refract Surg 1987;13:1275-89.

[37] Cheng H, McPherson K, Bron AJ. I. Cataract surgery: Interim results and complications of a randomised controlled trial. Br J Ophthalmol 1986;70:402-10.

[38] Oxford Cataract Treatment and Evaluation team (OCTET). Long term corneal endothelial cell loss after cataract surgery: Results of a randomised controlled trial. Arch Ophthalmol 1986;104:1170-75.

[39] Pizarello L. Intraocular lens use in developing countries. Ophth Surg 1989;20:240.

[40] Young PW, Schwab L. Intraocular lens implantation in developing countries: An ophthalmic surgical dilemma. Ophth Surg 1989;20:241-4.

[41] Pizarello L, Ellwin LB. The choise of cataract surgical techniques in developing nations: Operations research considerations. Int Ophthalmol 1990;14:147-54.

[42] Taylor HR, Sommer A. Cataract Surgery: A global perspective. Arch Ophthalmol 1990;108:797-8.

[43] Gupta AK, Tewari HK, Ellwein LB. Cataract surgery in India: Results of a 1995 survey of ophthalmologists. Indian J Ophthalmol 1998;46:47-50.

[44] Waring GO. The 50-Year epidemic of pseudophakic corneal edema. Arch Ophthalmol 1989;**107**:657.

[45] Lim ES, Apple DJ, Tsai JC, Morgan RC, Wasserman D, Assia EL. An analysis of flexible anterior chamber lenses with special reference to the normalised rate of lens explantation. Ophthalmology 1991;**98**:243-6.

[46] Auffarth UG, Wesendahl TA, Brown SJ, Apple DJ. Are there acceptable anterior chamber intraocular lenses for clinical use in the 1990s? An analysis of 4104 explanted anterior chamber intraocular lenses. Ophthalmology 1994:**101**;1913-22.

[47] World Health Organization. Report of the consultation on the use of intraocular lenses in cataract surgery in developing countries. 3-7 December 1990 WHO/PBL/91.1. Geneva.

[48] Snellingen T, Shrestha BR, Gharti M, Shrestha JK. Socio-economic barriers to cataract surgery in Nepal: The south Asian cataract management study. Br J Ophthalmol 1998;**82**:1424-8.

[49] Snellingen T, Rao GN, Shrestha JK, Huq F, Cheng H. Quantitative and morphological characteristics of the normal corneal endothelium: The south asian cataract management study (in consideration).

[50] South Asian Cataract Management Study Group. The south Asian cataract management study. I The first 662 cataract surgeries: a preliminary report. Br J Ophthalmol 1995;**79**:1029-35.

[51] Snellingen T, Shrestha JK, Fazlul H, Husain R, Koirala S, Pokhrel RP, Kolstad A, Upadhyay MP, Rao GN. The south asian cataract management study: complications, vision outcomes and corneal endothelium cell loss in a randomised multicenter clinical trial comparing intracapsular Cataract Extraction With and Without Anterior Chamber Intraocular Lens. (Submitted to Ophthalmology).

[52] Lewallen S, LeMeausurier RT. Extracapsular cataract extraction in developing countries. Arch Ophthalmol 1993;**111**:18.

[53] Powe NR, Schein OD, Gieser SC, Tielsch JM, Luthra R, Javitt J, Steinberg EP. Synthesis of the literature on visual acuity and complications following cataract extraction with intraocular lens implantation. Arch Ophthalmol 1994;**112**:239-52.

[54] Henning A, Evans JR, Pradhan D, Johnson GJ, Pokhrel RP, Gregson RMC, Hayes R, Wormald RPL, Foster A. Randomised controlled trial of anterior chamber intraocular lenses. Lancet 1997; **349**:1129-33.

[55] Natchiar GN, Thulasiraj RD, Negrel AD, Bangdiwala S, Rahmathallah R, Venkatesh Prajna N, Ellwein LB, Kupfer C. The Madurai Intraocular Lens Study I: A randomized clinical trial comparing complications and vision outcomes of intracapsular cataract extraction and extracapsular cataract extraction with posterior chamber intraocular lens. Am J Ophthalmol 1998;**125**:1-13.

[56] Venkatesh Prajna N, Chandrakanath KS, Kim R, Narendran V, Selvakumar S, Rohini G, Manoharan N, Bangdiwala I, Ellwein LB, Kupfer C. The Madurai Intraocular Lens Study II: Clinical outcomes. Am J Ophthalmol 1998;**125**:14-25.

[57] Vogel M, Behrens-Baumann W, Petersen J, Quentin CD, Hilgers R, Kron R, Hauptvogel A. Vergleich der Komplikationen nach intra intra und extrakapsularer kataraktextraktionen mit Linseimplantation: Ergebnisse einer prospective, randomisierten, klinischen studie. Klin Monatsbl Augenheilkd 1993;**203**:43-52.

[58] Williamson DE. Incidence of cystoid macular edema and retinal detachment after intracapsular cataract extraction and a modern anterior chamber iol. ASCRS Symposium on Cataract, IOL & Refr Surg, Boston April 8, 1991.

[59] Bates AK, Cheng H. Bullous keratopathy: a study of endothelial cell morphology in patients undergoing cataract surgery. Br J Ophthalmol 1988;**72**:409-12.

[60] Apple DJ Surgical approach should be dictated by the setting: Global Notebook. Ocular surgery news international July 1997:32.

[61] DJ Apple: The «Compleat» surgeon: March 4 , 1997. XVI Congress of Asia Pacific Academy of Ophthalmology.

[62] Shrestha JK, Snellingen T. South asian catract management study: one year follow-up. eye care delivery and service outcomes in south Asia. 1997. XVI Congress of Asia Pacific Academy of Ophthalmology.

[63] Pokharel GP. Cataract surgery: clinical and vision function outcomes. Eye care delivery and service outcomes in south Asia. 1997. XVI Congress of Asia Pacific Academy of Ophthalmology.

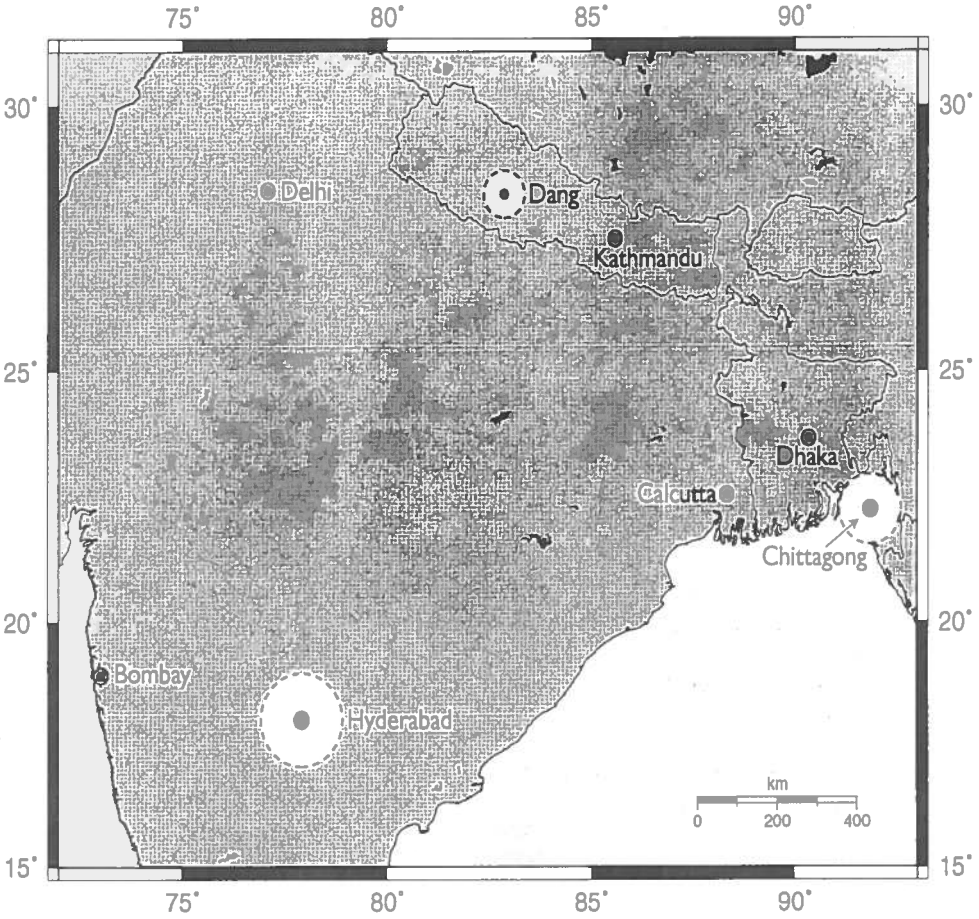
[64] Sui R. Outcomes of Cataract Surgery in China. Eye care delivery and service outcomes in south Asia. 1997. XVI Congress of Asia Pacific Academy of Ophthalmology.

[65] Pradhan YM. the Jhapa eye camp cataract management study in the Bhutanese refugee camps. General and Community Ophthalmology. March 5, 1997. XVI Congress of Asia Pacific Academy of Ophthalmology.

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

MAP

Location of participating centres and study field area



FIGURES

Figure 1. Patient flow - Paper I

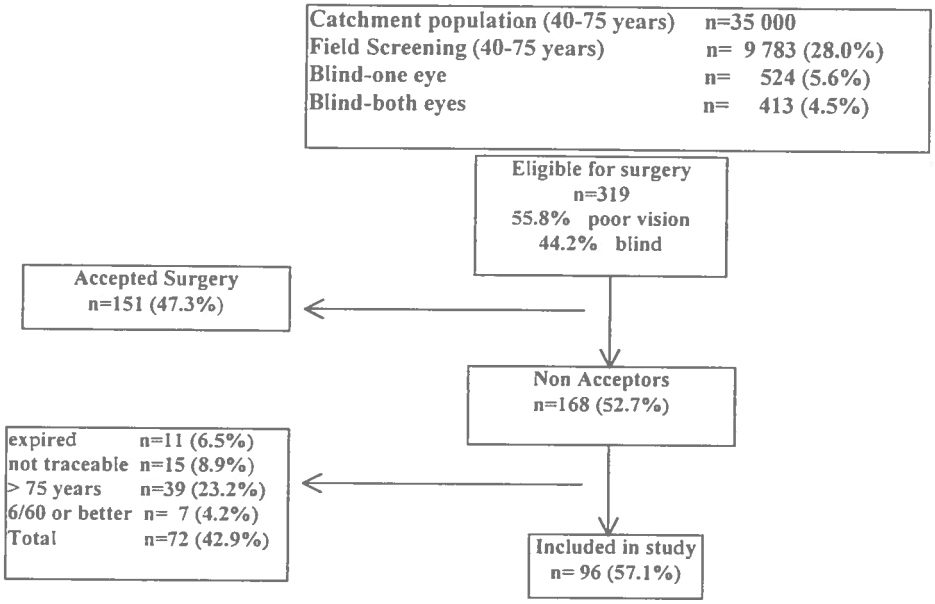
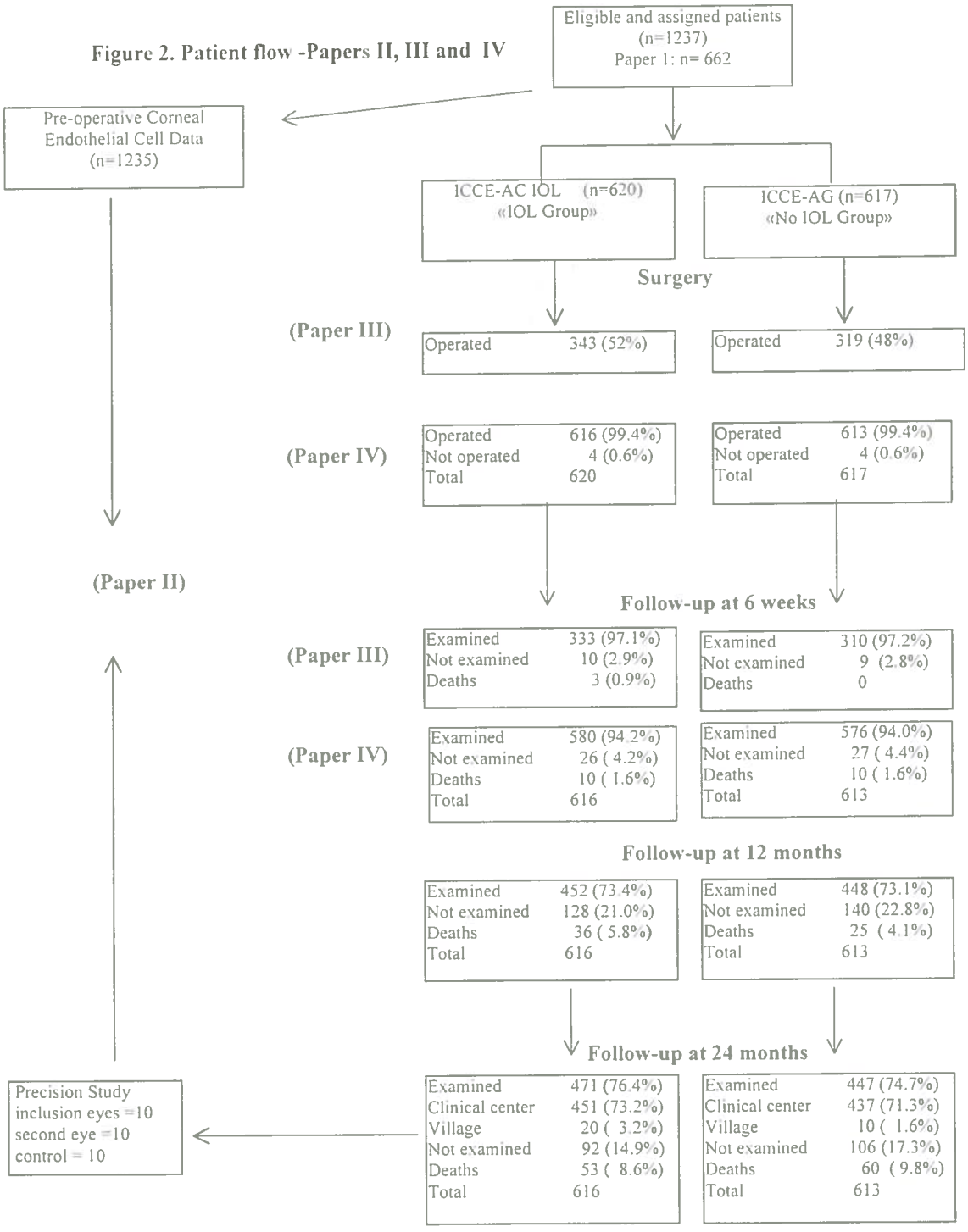


Figure 2. Patient flow -Papers II, III and IV



TABLES

Table 1. Advantages and disadvantages in intracapsular and extracapsular cataract extractions

Intracapsular surgery (ICCE)	*Extracapsular surgery (ECCE)*
Advantages	
1. Does not require sophisticated equipment 2. Most cataract surgeons in developing countries are adapt in the procedure 3. Average duration of surgery is less than for ECCE	1. Permits both anterior or posterior chamber lens implantation
Disadvantages	
1. Higher vitreous related complications 2. Permits anterior chamber lens implantation	1. Requires more sophisticated equipment and supplies 2. Increased training 3. More manipulation within the eye with greater risk of infection and inflammation 4. Posterior capsular opacification causes visual deterioration in 20-50% of cases, requiring secondary intervention (surgical or laser)

Table 2. Analysis of variance of multiple examinations of non operated eyes (n=6)

Eye*	Cells counted	Cell Density			Cell size variability			% Hexagonality		
	mean (sd)	mean	sd	% error†	mean	sd	% error†	mean	sd	% error†
1o	87 (52.1)	2335	66.5	2.8	34.0	6.4	18.9	58.2	11.2	19.3
1s	99 (37.2)	2218	112.0	5.1	34.2	3.9	11.3	51.0	8.7	17.0
1c	94 (28.6)	2880	100.9	3.5	42.0	2.0	4.8	44.5	10.5	23.6
2o	71 (36.2)	2367	213.2	9.0	49.0	8.0	16.3	40.3	14.3	35.5
2s	63 (22.5)	2291	220.7	9.6	42.5	2.8	6.6	41.2	9.9	24.2
2c	99 (20.6)	3205	104.3	3.3	42.0	4.7	11.3	46.2	11.6	25.1
3o	56 (34.8)	2467	108.4	4.4	35.8	2.8	7.8	46.3	20.3	43.8
3s	55 (11.4)	2162	90.6	4.2	40.7	2.4	6.0	48.3	10.5	21.7
3c	64 (31.8)	3097	190.0	6.1	44.3	11.0	24.9	37.0	10.8	29.2
4o	68 (24.9)	2486	127.6	5.1	43.7	6.4	14.7	36.0	13.0	36.0
4s	51.5 (9.6)	1905	139.1	7.3	44.0	1.7	3.8	36.3	10.1	27.7
4c	70 (31.3)	2355	97.0	4.1	39.8	5.7	14.3	55.0	19.3	35.0
5o	132 (46.0)	2890	123.4	4.3	40.2	5.3	13.2	45.8	6.6	14.4
5s	65 (18.3)	2575	88.3	3.4	37.8	4.7	12.4	39.5	11.5	29.2
5c	55 (15.0)	2752	315.5	11.5	39.7	5.3	13.4	50.7	6.0	11.8
6o	84 (40.0)	2036	139.0	6.8	43.8	3.9	8.8	41.5	12.5	30.2
6s	65 (18.3)	1392	86.1	6.2	48.5	3.9	8.1	40.8	9.0	22.0
6c	101 (29.0)	2465	151.7	6.2	51.2	5.5	10.7	438.7	6.2	16.0
7o	64 (28.6)	2168	233.6	10.8	54.0	13.8	25.5	33.3	17.6	52.8
7s	42 (12.2)	1885	207 .3	11.0	51.7	8.5	16.5	50.5		16.4
7c	111 (22.2)	3090	128.8	4.2	37.8	2.8	7.4	42.3	5.3	12.6
8o	112 (31.0)	2450	93.7	3.8	35.0	2.4	6.8	43.0	6.0	14.0
8s	67 (19.5)	1833	78.1	4.3	41.2	3.8	9.1	43.5	10.9	25.1
8c	65 (22.1)	2259	230.7	10.2	46.0	10.4	22.7	35.7	10.1	28.2
9o	110 (28.0)	3393	110.8	3.3	40.2	4.6	11.5	50.0	4.8	9.6
9s	98 (23.0)	3491	201	5.7	43.7	2.3	5.2	33.7	8.2	24.3
9c	58 (16.2)	2524	140.9	5.6	42.7	9.0	21.2	48.3	8.9	18.4
10o	58 (9.4)	2297	161.0	7.0	49.2	10.2	20.8	37.0	10.1	27.2
10s	36 (4.2)	2067	267.2	12.9	52.8	5.6	10.7	40.5	8.3	20.6
10c	87 (42.6)	2484	54.7	2.2	36.3	5.2	14.4	48.8	10.6	21.7

*o=operated eye;s=controlateral (non operated eye);c=non operated pre-operative eye of age and sex mateced control †error=100*sd/mean

Table 3. Cataract Surgical Outcome Studies

Study	Surgery	n	number followed up in %	functional vision less than 6/60	corrected vision less than 6/60
Clinical Trials (one year follow-up)*					
SACMS † [62]	ICCE-AG	147	94%	5.4 %	1.4%
South Asian Cataract Management Study	ICCE-AC IOL	139		2.9 %	2.2%
Lahan [54]	ICCE-AG	917	91%	5.4%	2.2 %
Sagarmatha Eye Hospital, Nepal	ICCE-AC IOL	918		5.1%	2.6 %
MIOLS [56]	ICCE-AG	1401	85%	2.4%	1.6%
Madurai Intraocular Lens Study	ECCE-PC IOL	1474		2.4%	2.3%
Population Studies					
(1 month to ten year follow-up)					
Nepal (1995) [63]	ICCE-AG &	216		31.1%	9.7%
China (1996) [64]	ICCE-AG & ECCE-PCIOL	115		45.2%	
Assessment of Eye Camps					
Central India (1987) [66]	ICCE-AG (eye camp)	415	90%		4.7%
(one year follow-up)	ICCE-AG (hospital)	82			2.5%
Eye Camp-Nepal (1996) [65]	ECCE-AG	82	60%	58.5%	28.7%
(one month to two year follow-up)	ECCE-PCIOL	84	60%	51.2%	9.7%

***Source: XVI Congress of Asian Pacific Academy of Ophthalmology -see literature; † Nepal data only ; ‡ less than 3/60**

Paper I

Reprinted from BRITISH JOURNAL OF OPHTHALMOLOGY, December 1998, Vol 82, No 12, p 1424-1428

Socioeconomic barriers to cataract surgery in Nepal: the south Asian cataract management study

T Snellingen, B R Shrestha, M P Gharti, J K Shrestha, M P Upadhyay, R P Pokhrel

Abstract

***Background*—Previous studies have shown that, despite an increasing availability of cataract surgery, important socioeconomic barriers exist in the acceptance of surgery in many rural areas of south Asia. Nepal has developed a comprehensive national network of eye hospitals but the surgical coverage for the treatment of cataract blind is still low.**

***Aims*—To determine the utilisation of cataract surgery and the level of physical and psychosocial impairment and the socioeconomic barriers to surgery in a group of non-acceptors of surgery.**

***Methods*—Of 319 cataract patients identified in a field screening 96 non-acceptors of surgery were interviewed 1 year after an offer to undergo surgery. The interview included questions on visual function, quality of life, and socioeconomic variables on acceptance of cataract surgery. The quality of life questionnaire was based on the field validated protocol addressing the impact of visual impairment on physical and psychosocial functions. The questionnaire was adapted to the local conditions after pretesting. Data were analysed by degree of visual impairment.**

***Results*—Of 319 cataract patients identified only 45.5% accepted surgery, with men accepting surgery more readily than women (RR=1.31; 95%CI=1.04–1.67) because of a significantly greater acceptance of surgery in men in the non-blind group. The acceptance rate was significantly higher in the blind group (RR=1.74; 95%CI=1.36–2.22) compared with those patients having impairment of vision and severe loss of vision. Of 96 non-acceptors interviewed only a further 13% accepted surgery after a second counselling. The most frequent reasons given for not accepting surgery were economic (48%) and logistical (44.8%) constraints followed by fear of surgery (33.3%) and lack of time (18.8%). Half of the subjects complained of problems with self care but only 10% needed help for their most basic every day activities. 17.7% said they needed help to visit neighbours and 26% needed help to attend the field or market.**

***Conclusions*—It was found that in this population with a majority of patients with severe vision loss and blind, even when offered transport and free surgery the utilisation of cataract surgery is below 60%. Medicine tends to be prescriptive based on technological advances that it is able to offer. Medical practice needs to develop a more holistic understanding of the needs of the communities cultivating a greater capability to analyse the role of cultural, social, and economic factors when planning medical services for the population.**

(*Br J Ophthalmol* 1998;82:1424–1428)

Institutes of Clinical and Community Medicine, University of Tromsø, Norway
T Snellingen

Ministry of Health, Ramshapath, Kathmandu, Nepal
B R Shrestha

SACMS Programme Office, Institute of Medicine, Kathmandu, Nepal
M P Gharti

BP Koirala Lions Centre for Ophthalmic Studies, Institute of Medicine, Kathmandu, Nepal
J K Shrestha
M P Upadhyay

Nepal Netra Jyothi Sangh, Nepal Eye Hospital, Kathmandu, Nepal
R P Pokhrel

Correspondence to:
Torkel Snellingen, MD, Institute of Community Medicine, 9037 University of Tromso, Norway.

Accepted for publication
3 June 1998

Worldwide cataract blindness continues to be the major cause of all blindness. It is estimated that 41.8% of all global blindness is caused by cataract.[1] The WHO-NPCB (National Programme for Control of Blindness) survey (1986–9) revealed that in India alone cataract is responsible for 81% of severe vision loss and blindness.[2] It is estimated that 9.7 million have severe visual impairment (less than 6/60) and 4.3 million are blind (less than 3/60) due to bilateral cataract. By the year 2020 the elderly population of 60 years and above is expected to double from today's number increasing the number of blind even more.[3 4] It is becoming clear, however, that strategies for reducing the cataract backlog are related not just to surgical considerations but equally important are issues related to levels of education, economic wealth, and occupation of the cataract patient and his or her guardian(s). Studies in India have shown that despite the rapid increase in the availability of quality services resulting in an increased awareness of the benefits of cataract surgery, surgical uptake is still low in the rural segments

Table 1 Visual function questionnaire

Variable	*Question*	*Grading*
Self assessment of vision	In general, would you say your vision (with glasses if you are wearing them) is:	very good, 1; good, 2; fair, 3; poor, 4
Visual function:		
Limitation of daily activities	To what extent does your eye sight limit you in your daily activities?	not at all, 1; a little, 2; quite a bit, 3; a lot, 4
Recognition of face	Do you have a problem recognising the face of a person standing near you?	not at all, 1; a little, 2; quite a bit, 3; a lot, 4
Identifying small objects	Do you have a problem recognising small or minute objects (such as grains or the lines on your hand)?	not at all, 1; a little, 2; quite a bit, 3; a lot, 4
Dark adaptation	Do you have a problem adjusting to darkness after being in bright light?	not at all, 1; a little, 2; quite a bit, 3; a lot, 4
Light adaptation	Do you have a problem adjusting to brightness after being in a dark place?	not at all, 1; a little, 2; quite a bit, 3; a lot, 4

Table 2 Distribution of acceptors of surgery by vision groups and sex. Initial screening

	All (<6/18)			Visual impairment and severe vision loss (<6/18–3/60)			Blind (<3/60)		
	Acceptors			Acceptors			Acceptors		
	No	n (%)	RR (95%CI)*	No	n (%)	RR (95%CI)*	No	n (%)	RR (95%CI)*
Male	103	56 (54.4)	1.31 (1.04–1.67)	64	30 (46.9)	1.72 (1.16–2.57)	39	26 (66.7)	1.17 (0.89–1.55)
Female	216	89 (41.5)	Ref	114	31 (27.2)	Ref	102	58 (56.9)	Ref
Total	319	145 (45.5)	p=0.027	178	61 (34.3)	p=0.008	141	84 (59.6)	p=0.29

*Male female RR.

of the society owing to substantial socioeconomic barriers to accepting surgery.[5]

In Nepal cataract is still the most important cause of blindness despite the presence of a network of eye hospitals distributed throughout the country.[6] One may therefore assume that one of the reasons for the high cataract blindness prevalence is the low utilisation of the services. The main aim of this study was to describe the surgical uptake in a rural community serviced by a local eye hospital, determine possible reasons for non-acceptance of surgery, and compare these findings with the findings of other current and previous studies. We were also interested to explore impairment of visual and psychosocial functions and whether these influenced the decision making process of accepting surgery.

Table 3 Self reported visual function of the subjects included in interview (non-acceptors) by vision group*

	Visual impairment and severe vision loss (<6/18–3/60) (n=47)	Blind (<3/60) (n=49)	
	Mean score (SD)	Mean score (SD)	p Value†
Limitation of daily activities	2.62 (0.87)	3.27 (0.86)	0.0004
Recognition of faces	1.92 (1.00)	3.04 (1.00)	<0.0001
Identifying small objects	2.43 (1.16)	3.33 (0.85)	<0.0001
Dark adaptation	2.74 (1.0)	3.37 (0.78)	0.0008
Light adaptation	1.98 (0.87)	2.92 (0.93)	<0.0001

*Categories: 1, not at all; 2, a little; 3, quite a bit; 4, a lot; †test between vision groups.

Table 4 Reasons reported for not accepting surgery by visual categories

	All (<6/18) (n=96)	Visual impairment and severe vision loss (<6/18–3/60) (n=47)	Blind (<3/60) (n=49)	
	n (%)	n (%)	n (%)	RR (95%CI)*
Economic				
patient	48 (50.0)	20 (42.6)	28 (57.1)	1.34 (0.89–2.03)
guardian	46 (50.6)	18 (40.9)	28 (59.6)	1.46 (0.95–2.23)
agreement†	0.88	0.93	0.83	
Logistics				
patient	43 (44.8)	23 (48.9)	20 (40.8)	0.83 (0.53–1.30)
guardian	36 (39.6)	18 (40.9)	18 (38.3)	0.94 (0.56–1.56)
agreement	0.81	0.82	0.81	
Fear				
patient	32 (33.3)	16 (34.0)	16 (34.0)	0.96 (0.65–1.69)
guardian	33 (36.3)	18 (40.9)	15 (31.9)	0.78 (0.45–1.35)
agreement	0.82	0.75	0.89	
Time				
patient	18 (18.8)	12 (25.5)	6(12.2)	0.48 (0.20–1.17)
guardian	11 (12.1)	7 (15.9)	4 (8.5)	0.53 (0.17–1.70)
agreement	0.89	0.91	0.87	
No faith				
patient	13 (13.5)	8 (17.0)	5 (10.2)	0.60 (0.21–1.70)
guardian	4 (4.4)	2 (4.6)	2 (4.3)	1.07 (1.16–7.26)
agreement	0.90	0.86	0.94	
Adequate vision				
patient	13 (13.5)	10 (21.3)	3 (6.1)	0.29 (0.08–0.95)
guardian	10 (11.0)	7 (15.9)	3 (6.4)	0.40 (0.11–1.46)
agreement	0.91	0.84	0.98	

*Test between vision groups; †number of patients and guardians with equal responses/total.

Subjects and methods

The study was conducted from October 1992 to January 1993 in the mid western development region in the low lands of Nepal just north of the Ganges plain. There is a metalled road going across the lower valley and a fair weather road traversing the upper valley. The total population is 354 413 (1991 census) comprising predominantly illiterate rural farmers. The district has a 50 bed eye hospital that has been fully operational since 1989. The hospital performs approximately 600 cataract operations annually. Intracapsular cataract surgery with aphakic spectacle correction is the primary surgery of choice.

All the inhabitants aged 40–75 from 39 village administrative units and two town municipalities of Dang district were invited to have their vision examined by specially trained local health and social workers. Those who were identified with visual impairment were referred to mobile screening camps organised by the eye hospital. Those with presenting vision less than 6/60 in the better eye as a result of cataract were invited to have cataract surgery. Transport from the nearest road to the hospital was provided free of cost; however, all patients were made aware of the 200 Nepalese rupees (£2.30) charge for surgery. At the hospital, patients who met predetermined eligibility criteria were invited to participate in a study on cataract surgery.[7] Those who chose not to participate in the study received the routine treatment of the eye hospital.

One year after the initial screening those who were between 40 and 75 years of age and had not undergone cataract surgery were visited by a team comprising one eye examiner and one interviewer. Each patient's vision was re-examined and the patient and his/her relative (husband, wife, son, or daughter) were interviewed. The sources of the questions for the interviews were taken from validated visual function and a quality of life questionnaire addressing the impact of visual impairment on physical and psychosocial functions.[8 9]

The interview included questions on visual function (Table 1), acceptance of cataract surgery in relation to socioeconomic variables, questions concerning self care, and self evaluated psychosocial esteem. The questionnaire was developed in English and then translated to Nepali and the local tribal language. The translated versions were field tested and final adjustments were made. The interviews were conducted by a public health officer. A translator for the local tribal language was used when necessary.

Table 5 Reported need of assistance in everyday activities because of vision loss*

	All (<6/18) (n=96)	Visual impairment and severe vision loss (<6/18–3/60) (n=47)	Blind (<3/60) (n=49)	
	n (%)	n (%)	n (%)	RR (95%CI)†
Self care:				
bathing				
patient	22 (22.9)	3 (6.4)	19 (38.8)	6.07 (1.92–19.19)
guardian	22 (24.2)	4 (9.1)	18 (38.3)	4.21 (1.55–11.48)
agreement‡	0.86	0.91	0.81	
toilet				
patient	9 (9.4)	1 (2.1)	8 (16.3)	7.6 (1.0–59.0)
guardian	10 (11.0)	1 (2.3)	9 (19.2)	8.43 (1.11–63.8)
agreement	0.95	1.0	0.89	
eating				
patient	5 (5.2)	0	5 (10.2)	
guardian	9 (9.9)	1 (2.3)	8 (17.0)	7.49 (0.98–57.47)
agreement	0.93	0.98	0.89	
dressing				
patient	10 (10.4)	0	10 (20.4)	
guardian	10 (11.0)	0	10 (21.3)	
agreement	0.96	1.0	0.91	
Mobility:				
visit neighbour				
patient	17 (17.7)	2 (4.3)	15 (30.6)	7.19 (1.74–2.98)
guardian	21 (23.1)	1 (2.3)	20 (42.6)	18.72 (2.62–133.71)
agreement	0.91	0.98	0.85	
work in field or go to market				
patient	25 (26.0)	3 (6.4)	22 (44.9)	7.03 (2.25–22.0)
guardian	20 (22.0)	1 (2.3)	19 (40.4)	18.22 (2.54–130.8)
agreement	0.92	0.95	0.89	

*Categories: 1, no problem; 2, a little problem; 3, some problem; 4, very problematic; †test between vision groups. ‡Number of patients and guardians with equal responses/total.

EPI-INFO Version 6.04 was used for the statistical analysis. Categorical variables were tested with the χ^2 test or Fisher's exact test. The data were analysed according to two vision groups: 1, visual impairment and severe vision loss (WHO categories I and II = visual acuity less than 6/18 and equal to or greater than 3/60 in better eye); and 2, blind (WHO category III–V = visual acuity less than 3/60 in better eye). Agreement coefficients between patient and guardian were calculated by adding the number of patients and guardians with equal responses and dividing by total responders.

Results

In the initial screening exercise 9783 inhabitants were examined. Of these 524 (5.6%) were blind in one eye and 413 (4.5%) were blind in both eyes. Of these, 319 subjects were eligible for cataract surgery, 103 (32.3%) men and 216 (67.7%) women. Within 12 months 145 (45.5%) accepted surgery at the local eye hospital and six (1.9%) had surgery at other hospitals. Table 2 shows the number of acceptors and non-acceptors of surgery by degree of visual impairment and by sex. The male population were more likely to accept surgery than females (RR=1.31; 95%CI=1.04–1.67). This was due to a highly significant difference in the visually impaired group (RR=1.72; 95%CI=1.16–2.57). There was no statistically significant difference between sexes in the blind group (RR=1.17; 95%CI=0.89–1.55). Of the acceptors 57.9% were blind compared with 32% of the non-acceptors (p <0.0001). The difference in acceptance of surgery between vision groups was highly significant (RR=1.74; 95%CI=1.36–2.22).

Of the patients who did not accept cataract surgery after 1 year of the screening procedure, 11 (3.4%) had died. Thirty nine (12.2%) patients were over the age of 75 and were excluded for practical reasons. Of the 118 eligible for inclusion in the programme 15 were not traceable.

The visual screening was performed on the remaining 103 subjects. Of these, seven had a presenting vision better than 6/60 and were excluded. Ninety six (57.1%) of the non-acceptors were included for the interview. Sixty seven (69.8%) were females and 91 (94.8%) were illiterate. There were no significant differences between vision groups. Table 3 presents mean score of self reported visual function by vision groups. As expected the blind had a significantly poorer self reported visual function than the visually impaired group—77.7% complained of limitations of daily activities;

Table 6 Reported psychosocial impairment because of vision loss*

	All† (<6/18) (n=96)	Visual impairment and severe vision loss (<6/18–3/60) (n=47)		Blind (<3/60) (n=49)		
	n (%)	n (%)	Mean score (SD)	n (%)	Mean score (SD)	p Value‡
Social:						
attending ceremony						
patient	69 (71.9)	28 (59.6)	1.81 (0.85)	41 (83.7)	2.65 (1.10)	0.0017
guardian	72 (79.1)	31 (70.4)	1.89 (1.01)	41 (87.2)	2.61 (1.19)	0.002
agreement§	0.55	0.66		0.45		
meeting people						
patient	61 (63.5)	22 (46.8)	1.85 (1.0)	39 (79.6)	2.47 (1.38)	0.008
guardian	68 (74.7)	29 (65.9)	1.62 (0.8)	39 (83.0)	2.35 (0.99)	0.0001
agreement	0.55	0.66		0.45		
Psychological:						
burden to others						
patient	68 (70.8)	27 (57.5)	1.79 (0.97)	41 (83.7)	2.14 (1.06)	0.1
guardian	65 (71.4)	29 (65.9)	1.86 (0.88)	36 (76.6)	2.49 (1.0)	0.002
agreement	0.57	0.61		0.53		
feeling dejected						
patient	68 (70.8)	29 (61.7)	1.92 (0.93)	39 (76.6)	2.49 (1.10)	0.009
guardian	39 (42.9)	29 (65.9)	1.81 (0.95)	10 (21.3)	2.10 (1.10)	0.25
agreement	0.63	0.64		0.62		
loss of confidence						
patient	78 (81.3)	33 (70.2)	2.04 (0.91)	45 (91.8)	2.53 (0.87)	0.008
guardian	59 (64.8)	28 (63.6)	1.81 (0.99)	31 (66.0)	1.84 (0.97)	0.88
agreement	0.47	0.52		0.43		

*Categories: defined as 1, not at all; 2, a little; 3, quite a bit; 4, a lot. †Absolute number reporting any impairment. ‡Test between vision groups; §number of patients and guardians with equal responses/total.

Table 7 Vision change 1 year after initial screening (n=96)

Previous vision	Present vision*				
	I n (%)	*II n (%)*	*III n (%)*	*IV n (%)*	*All n (%)*
I	18 (18.8)	13 (13.5)	3 (3.1)	0	34 (35.4)
II	1 (1.0)	12 (12.5)	14 (14.6)	1 (1.0)	28 (29.2)
III	3 (3.1)	0	15 (15.6)	6 (6.3)	24 (25.0)
IV	0	0	0	10 (10.4)	10 (10.4)
All	22 (22.9)	25 (26.0)	32 (33.3)	17 (17.7)	96

*Categories (WHO): I=less than 6/18–6/60; II=less than 6/60–3/60; III=less than 3/60–1/60; IV=less than 1/60 to perception of light; kappa statistic=0.437, z=7.41, p <0.001.

83.3% and 42.8% had problems recognising people at distance and at near respectively; 59% had difficulties in identifying small objects; and 73.9% had problems adapting to darkness.

Table 4 presents self reported and the guardian reported reasons for not accepting surgery. Economic refers to costs as patient fees for surgery, loss of income during hospital stay, food, etc. Logistics refers to the guardian's willingness or capability to accompany the patient. Economic and logistical constraints were the two most important reasons given for not accepting surgery, 50% and 44.8% respectively. Other reasons given were fear of surgery (33.3%) and lack of time because of harvesting and planting (18.8%). These variables showed a good agreement between subject and guardian. There were no statistically significant difference between visions groups for any of these variables.

The reported need for assistance in everyday activities (Table 5) showed that only 22.9% needed help in bathing, 9.4% in going to the toilet, 5.2% in eating, and 10.4% in dressing. Over 17% had problems visiting neighbours and 26.0% in working in the field or going to the market; 77% did not need assistance in their daily activities (data not shown). There was good agreement between the subject and the guardian in reporting of these variables. There were significant differences between vision groups for all variables addressing daily activities. As expected those with the poorest vision reported more frequently the need for assistance than those with better vision ($p < 0.05$).

Table 6 shows the degree of psychosocial impairment. There was a general perception in over half of the subjects of being a burden to the family, feeling dejected, and having lost self confidence. Analysis of the psychosocial functions showed significant differences between vision groups for most variables. Except for consideration of burden the group with poorest vision reported consistently poorer quality of life. For these variables there was a poorer agreement between the patient and guardian than what was found for variables addressing physical impairment. The guardian had a tendency to report a better psychosocial function than what was reported by the patient himself. For the patients there was no significant difference between the two vision groups in consideration of being a burden; however, the guardians perceived that those with poorer vision were significantly a greater burden than those with the better vision. Patients with poorer vision complained more frequently of being dejected than those with better vision. Their guardian, however, did not report such differences.

One year after the initial screening 37.5% had a further deterioration of vision ($p<0.01$) (Table 7). When asked again about the willingness to accept surgery 66.7% said they were now ready to have cataract surgery (Table 8); however, within 1 year of the interview only 24.0% had undergone treatment and there was no significant difference between vision groups. There was good agreement between self reported and guardian reported willingness to accept surgery.

Discussion

We have found in this population of illiterate farmers in rural Nepal that, even when offered free transport, under half the population accept surgery within 1 year. There was, in general, good agreement between what the patients and the relatives reported were reasons for not accepting surgery. There was also good agreement in perception of impairment of daily function and need for assistance in daily activities. As may have been expected, in answering questions concerning impairment of psychosocial functions, there was a poor agreement with the patients' perceptions of impairment being greater than the perception of the relatives.

Although a majority of the non-acceptors said they were willing to have surgery, even with the promise of free treatment, only 24% actually had surgery within the following year. For this population the promise of free surgery did not seem to be the main motivational factor to accept treatment. Other considerations such as the opportunity costs of being away from daily income earning activities together with the lack of the patient's own

Table 8 Self reported and guardian's reported agreement to surgery and acceptance of surgery by vision group

	All (<6/18) (n=96)	*Visual impairment and severe vision loss (<6/18–3/60) (n=47)*	*Blind (<3/60) (n=49)*	
Acceptance of surgery	*n (%)*	*n (%)*	*n (%)*	*p Value**
Without economic incentive				
Self reported	64 (66.7)	29 (61.7)	35 (71.4)	0.77
Guardian	69 (71.9)	30 (63.8)	39 (79.6)	0.72
Agreement	0.93	0.97	0.90	
With economic incentive				
Self reported	59 (61.5)	29 (61.8)	30 (61.2)	0.96
Guardian	64 (66.7)	28 (60.0)	36 (73.5)	0.15
Agreement	0.92	0.97	0.83	
Surgery undertaken within 1 year of interview	23 (24.0)	12 (25.5)	11 (22.4)	0.72

*Test between vision groups.

motivation seem to be more important. The costs and efforts needed to undergo treatment seem greater than the perceived value of visual rehabilitation. A substantial number of subjects had a perception of limitations of daily activity and impairment of visual and psychosocial function. That a majority of patients still retain enough vision to maintain personal hygiene, dress, eat independently, and retain enough mobility to get about and around the household, seems to be an important determinant for not accepting surgery. Over 77% of the 96 non-acceptors interviewed had no need of assistance in their everyday activities and therefore did not think surgery was required, signalling differences between the doctors' perceptions on indication for surgery and the perceptions of the patient and his/her relative(s).

Despite our finding that the female population is more likely to have visual impairment due to cataract than the men, for the group with visual impairment and severe vision loss it is the male population that more readily accepts surgery. This is probably the result of the differences in the roles of males and females of the age group affected, with the male population being more mobile and the female population being traditionally more confined to the household.

The Nepal blindness survey (1981) found the overall cataract surgical coverage (the number of aphakics in the population divided by the sum of the number of aphakics and unoperated cataract blind) to be 35%. In the plains of the mid western region the surgical coverage was 32% (vision less than 3/60 better eye).[10] A follow up of this survey (1995) showed that the surgical coverage had increased by only 10% despite the existence of well established eye hospitals in the area.[11] The utilisation of services was almost twice as great in the urban areas compared with the rural areas. This survey and previous studies[12] indicate clearly that, even when there is awareness of the availability of treatment, it is the urban, affluent, and literate segments of the society that seek the services. In a study based on interviews with cataract patients in rural areas of Madurai, southern India, surgical acceptance was 13.6% for a group of patients who had surgery without any interventions or incentives, while with intervention and the full economic incentive, including free treatment and free eyeglasses, the acceptance was 33.3%.[13] The cost of the procedure was not the principal deterrent to undergoing surgery but rather the lack of social support and a perception that the procedure was not needed, thus highlighting the wide gap existing between the medical community's perception of patient needs and patients' own perceptions of their needs. In our study in a typical farming population of rural Nepal, we found that with intense counselling and an offer of logistical support in the form of free transport, the surgical coverage was 46% (patients with vision less than 6/60 better eye). This increased by 13% when further counselling and a economic incentive of offering free surgical treatment was included.

In the group of non-acceptors, the degree of visual impairment was not a determinant for having surgery (Table 8).

Increased surgical uptake will most likely be influenced first and foremost by changes in perceptions of the benefits of cataract surgery in the local community. This is influenced by the quality of previous surgery with resulting positive propaganda of the successfully operated cataract patients or aphakic motivator. In addition, as has also been shown in previous studies, factors like literacy and education are important determinants for accepting surgery. Medicine tends to be prescriptive based on technological advances that it is able to offer. Medical practice needs to develop a more holistic understanding of the needs of the communities cultivating a greater capability to analyse the role of cultural, social, and economic factors.[14 15] Next to the quality of services, it is likely that real changes in economic wealth and adult literacy in the communities, particularly in the female population, will be the most important determinants for improving the surgical uptake.

1 Thylefors B, Negrel AD, Pararajasegaram R, *et al*. Global data on blindness. *Bull World Health Organ* 1995;73:115–21.
2 Jose R, Bachani D. World Bank-assisted cataract blindness control project. *Indian J Ophthalmol* 1995;43:35–43.
3 Minassian DC, Mehra V. 3.8 Million blinded by cataract each year:projections from the first epidemiological study of incidence of cataract blindness. *Br J Ophthalmol* 1990;74:341–3.
4 Limburg H, Kumar R, Bachani D. Monitoring and evaluating cataract intervention in India. *Br J Ophthalmol* 1996;80:951–5.
5 Padmashree G, Wenkataswamy MS, Brilliant G. Social and economic barriers to cataract surgery in rural south india: a preliminary report. *Visual Impairment and Blindness* December 1981:405–8.
6 Kupfer C. The International Agency for the Prevention of Blindness. *Am J Ophthalmol* 1994;117:253–7.
7 The South Asian Cataract Management Study Group. The south Asian cataract management study. I The first 662 cataract surgeries: a preliminary report. *Br J Ophthalmol* 1995;79:1029–5.
8 Ellwein LB, Fletcher A, Negrel DA, *et al*. Quality of life assessment in blindness prevention interventions. *Int Ophthalmol* 1995;18:263–8.
9 Fletcher EF, Ellwein LB, Selvaraj S, *et al*. Measurements of vision function and quality of life in patients with cataracts in southern India. *Arch Ophthalmol* 1997;115:767–73.
10 Seva Foundation. The epidemiology of blindness in Nepal. Report of the 1981 Nepal Blindness Survey;212–8.
11 Regmi G, Pokahrel GP. Cataract blindness prevalence in Bheri and Lumbini zones. Eye Care delivery and service outcomes in south Asia. XVI Congress of Asia Pacific Academy of Ophthalmology. 4 March 1997.
12 Brilliant GE, Brilliant LB. Using social epidemiology to understand who stays blind and who gets operated for cataract in a rural setting. *Soc Sci Med* 1985;21:553–8.
13 Brilliant GE, Lepkowski JM, Zurita B, *et al*. Social determinants of cataract surgery utilization in south India. *Arch Ophthalmol* 1991;109:584–9.
14 Helman CG. *Culture, health and illness*. Oxford: Butterworth-Heinemann, 1994.
15 Coreil J, Mull D, eds. *Anthropology and primary health care*. Boulder, CO: Westview Press, 1990.

Paper II

Title:

Quantitative and morphological characteristics of the human corneal endothelium in relation to age, sex and ethnicity in cataract populations of south Asia

Names of authors:

Snellingen T, MPH[1], Rao N Gullapalli, MD [2], Shrestha K Jeevan, FRCS, FCOphth [3], Huq Fazlul, DO, MPH[4], Cheng Hung, FRCS, FCOphth[5]

Financial support :

The study has been funded by a Norwegian Government Grant: Norwegian Universities' Council for Development Research and Education-NUFU grant # 17/91

Running Head :

Human corneal endothelium in cataract populations

Correspondence to Torkel Snellingen MD, Institute of Community Medicine, 9037 University of Tromsø, Norway

telephone: +47 77 644816 fax: + 47 77 644831

e-mail: torkel.snellingen@ism.uit.no

[1] Senior Lecturer, Department of Ophthalmology, Institute of Clinical Medicine, University of Tromsø. Norway

[2] Director , L.V. Prasad Eye Institute, Hyderabad, India

[3] Senior Lecturer, B.P. Koirala Lions Centre for Ophthalmic Studies, Institute of Medicine, Tribhuvan University Kathmandu, Nepal

[4] Assistant Professor,Institute of Community Ophthalmology, Chittagong University, Bangladesh

[5] Consultant Ophthalmologist Oxford Eye Hospital, Honorary Senior lecturer, University of Oxford, U.K.

Keywords:

Corneal endtohelium cells, senile cataract, south Asia

Abstract

Purpose: To describe the differences of corneal endothelial cell densities, cell size variability and cell hexagonality in cataract populations of south Asia between sexes and ethnic groups.

Methods: 1235 eyes of 1235 male and female patients 40-75 years of age with senile cataract were examined with non contact specular microscopy with semi-automated analysis technique. The cell data of the study population was analyzed in relation to age, sex, and ethnic groups. Mean arithmetic differences and the coefficient of variation of repeated observations were calculated to estimate precision of the technique utilized. The main outcome measures were corneal endothelial cell density, cell size variability and cell hexagonality.

Results: The mean corneal endothelial cell density was 2720 cells per mm^2, mean cell size variability was 37.8% and percent cell hexagonality 40%. We found statistical significant difference between the three ethnic populations in all the corneal endothelial cell measurements ($p<0.0001$). Females had a 2.9% greater cell density than males ($p=0.0001$). There was no significant difference in mean cell density according to age. Variability of cell size, however, increased with age ($p < 0.001$). These findings were consistent across the three ethnic groups.

Conclusions: In a total sample of 1235 eyes distributed evenly in three cataract patient populations of south Asia, we found statistically significant differences of corneal endothelial cell densities of cell size variability and cell hexagonality between sexes and ethnic groups.

Vogt first observed the corneal endothelial cells through the specular reflection of the biomicroscope in 1920. From 1975, with the introduction the specular microscope for clinical use by Laing et al [1] and subsequently by Bourne and Kaufman [2], numerous studies using both small and wide field specular microscopy have described the normal corneal endothelium [3]. Hirst and coworkers found in their quantitative analysis of wide and small field specular microscopy [4] that both techniques provides an accurate representation of the true mean of cell size in about 80% of the time but as endothelium becomes more irregular the accuracy of samples diminishes greatly. Previous studies have suggested that there is a continuous cell loss from the third to fourth decades of life [5-10]. Due to the increasing variability of the individual cell populations of central corneas after the third decade of life, increasing sample sizes are needed to detect true differences in subgroups of the population. To our knowledge none of the previous studies that have looked at age and corneal endothelial cells included a sample larger than 150 eyes and only one study has described the corneal endothelium across different population groups [11]. In this article we describe the pre-operative central corneal endothelium cells according to age, sex and ethnic group of 1235 eyes as part of a baseline examination for a clinical trial on cataract surgery.

Patients and Methods

From January 1993 to December 1995, 1235 eyes of 1235 cataract patients between 40-75 years of age were examined pre-operatively with non contact specular microscopy. The patients were from three ethnically distinct regions of south Asia: Andhra Pradesh, south India, Chittagong, Bangladesh and south western Nepal [12]. Patients with acute or chronic corneal disease were excluded [13,14]. All centers use the same non contact specular microscopy and digital image and analysis techniques. 2 ophthalmic assistants were specially

trained by the same instructor visiting all three participating centers. Small field (0.08 mm^2) specular microscopy was taken of one eye using a SL-7F slitlamp with a non contact specular attachment set at 25X magnification. The images were captured and digitized using the IMAGEnet Cell Soft™ version 3.5. The best image was saved on optical cartridges. Image analysis was done using the *semiautomatic analysis* option of the software [15]. 90 % of the analysis included 60 cells or more (mean =92 ; sd=20; range=22-261). The quality of images was systematically reviewed and a visual assessment was cross checked with the data from the semiautomatic analysis by the same study monitor visiting all three centers. When errors of analysis were suspected the analysis were repeated by both the study monitor and the local examiner and an agreement was reached.

The following three variables were measured:

1-central endothelial cell density defined as *the number of cells per* mm^2 ;

2-central corneal endothelial cell size variability or the coefficient of variation defined as *sd/x* where *sd* is the standard deviation of the cell size expressed as a percentage and *x* is the mean cell size;

3-central corneal endothelial hexagonality defined as the *percentage of cells having six bordering cells.*

A sampling error study was conducted by taking serial images of the central cornea of 10 consecutive cases both of the operated eye and the non operated contra-lateral eye. Every case had a age and sex matched control. A total of 6 images were taken of each eye. Two examiners made three examinations at three consecutive sittings.

Three images were taken at each sitting with the best image saved for further analysis. A total of 180 digital images were available for analysis. Mean arithmetic differences between observers and within observers were calculated to estimate reproducibility of corneal

endothelial cell measurements. The formula used for calculating the coefficient of variation of differences was cv= 100 x s/$\bar{x}$ where s is the measurement error and $\bar{x}$ is the mean value of the corneal endothelial cell measurement. The cell data of the study population was analyzed in relation to age, sex and ethnic groups and adjustments were made with analysis of co-variance. Statistical Analysis System (SAS) version 6.11 for windows was used for the statistical computations.

Results

The patient population consists of 610 (49.4%) males and 625 (50.6%) females with a mean age of 61.5 (sd=7.6) for males and 59.5 (sd=7.4) for females.

The precision estimates of the measurements of corneal endithelium cell data is presented in Table 1. The mean number of cell counted for this analysis was 77 cells/mm^2 (sd=23.5). The coefficient of variation (cv) of mean difference between repeated measurements for the cell density was for between and within observers was 5.2% and 6.4% respectively. For the cell size variability the cv was 14.2% and 11.7% and for cell hexagonality 25.5% and 29.8%.

Table 2 presents the distribution of cell density, cell size variability and hexagonality between the different ethnic groups and between sexes. There were statistically significant differences between ethnic groups in cell density, cell size variability and cell hexagonality. Between the three patient populations mean cell density varied from 2634 cells/mm^2 in western Nepal to 2782 cells/mm^2 in southern Bangladesh ($p = 0.0001$), while mean cell size variability varied from 33.2% in south Bangladesh to 41.2% in south India ($p < 0.0001$).

Between sexes females had a 2.9% greater cell density and a 7.8% higher percentage of hexagonal cells than males. There was, however, no significant difference between sexes in cell size variability. Table 3 shows that the cell density did not differ significantly between age groups (p=0.12), however, there was a significant increase in cell size variability with

increasing age ($p<0.001$). These findings were consistent across the three ethnic groups (data not shown). In the overall study population, as was expected, there was a slight but statistically significant inverse correlation between cell density and cell size variability, a significant positive relationship between cell density and percentage of hexagonal cells, and a inverse relationship between the percentage of hexagonal cells and cell size variability (table 4).

Discussion

Hirst et al showed in their quantitative analysis using precision sampling from the central corneal endothelium [4] that to be able to generate accurate data using small or wide-field specular microscopy large enough groups of patients are needed to compensate for the high variability demonstrated by current sampling techniques. It has also been shown that the accuracy of the findings decreases with increasing polymegathism and the confidence intervals widens, indicating that the sample may be as far off as much as 30-60% from the true mean. The studies that have described the corneal endothelium to date have included small samples giving unacceptably large population sampling errors.

The precision of the semiautomatic analysis software programme for the corneal endothelial cell density measurements analysis was tested by Vecchi et al [15]. Confidence limits and standard errors of mean differences between values obtained by different methods were used to to evaluate agreement and reproducibility of the computerized method. Sensitivity and specificity were calculted for two different treshold limits of endothelial cell density. The semiautomated Image-NET system , in half the analysis time required by the manual method (digitilized cell tracings), provided endothelial cell count estimates that were not clinically different from those obtained from manual counting. As was shown by our study, the study described above and other studies [7,16,17], non contact specular microscopy gives excellent precision for the corneal endothelial cell measurements and adequate precision for cells size variability and hexagonality in large population samples.

In this study population of 1235 eyes of 1235 subjects we have for the first time been able to describe differences of corneal endothelial cell density, cell size variability and cell hexagonality in the human corneal endothelium between sexes and between ethnic groups in a large cataract population of three different regions of south Asia. Based on our sample size we are confident that the analysis of cell data in respect to the three variables reflects real differences in the sub-groups both in relation to age, sex and the different population groups. The results of analysis of cell data between sexes at center level, although not statistically significant for all three variables, showed remarkable consistency across the three participating centres (Table 2).

Several authors have observed significant corneal endothelial cell loss with age until the fourth decade(5,6,8,10). Smaller cohort studies have shown evidence of significant differences in corneal endothelial cell density of eyes measured at two different point in time (Bourne et al: examinations at 10 years intervals [18]) however no significant correlation between cell loss rate and age have been found likely due to the significant increase of polymegathism from the fourth decade. In our study population we found a highly significant increase in polymegathism but no significant increase in corneal endothelial cell density for the age group 40 and above.

Matsuda et al in their study [11] comparing 73 eyes of 73 subjects of all age groups in an American population and equal number of eyes of subjects of a Japanese population suggested that there are ethnic differences in the corneal endothelial cell density between these population groups and that the higher cell count found in the Japanese population could be related to a lower incidence of aphakic bullous keratopathy. If differences in the characteristics of human corneal endothelium between population groups exist, as also is

suggested by this study, what could be the possible clinical implications of these findings? Can there be possible differences in the vulnerability of corneal endothelium to surgical trauma across ethnic groups ? New and improved corneal endothelial cameras using modern digital imaging technology have now been developed for routine clinical use. Further clinical studies of large populations of pre-operative and post-operative corneal endothelium across different ethnic groups should be undertaken to give further evidence that can refute or strengthen these findings.

References

[1] Laing RA, Sandstrom MM, Leibowitz HM. In vivo photomicrography of the corneal endothelium. *Arch Ophthalmol* 1975;93:143-5.

[2] Bourne WM, Kaufman HE. Specular microscopy of human corneal endothelium in vivo. *Am J Ophthalmol* 1976;81:319-23.

[3] Committee on Ophthalmic Procedure Assessment. Corneal endothelial cell photography: three-year revision. *Ophthalmology* 1997; 104:1360-5.

[4] Hirst LW, Yamauchi K, Enger C, et al. Quantitative analysis of wide field specular microscopy. II Precision of sampling from the central corneal endothelium. *Invest Ophthalmol* Vis Sci 1989;30:1972-9.

[5] Yee RW, Matsuda M, Schultz RO, Edelhauser HF. Changes in the normal corneal endothelial cellular pattern as a function of age. *Curr Eye Res* 1985;4: 671-7.

[6 Sturrock GD, Sherrard ES, Rice NSC. Specular microscopy of the corneal endothelium. *Br J Ophthalmol* 1978;62:809-14.

[7] Cheng H, Jacobs PM, McPherson K, Noble MJ. Precision of cell density estimates and endothelial cell loss with age. *Arch Ophthalmol* 1985;103:1478-81.

[8]Laing RA, Sandstrom MM, Berrospi AR, Libowitz HM. Changes in the corneal endothelium as a function of age. *Exp Eye Res* 1976;22:587-94.

[9] Rao GN, Waldron WR, Aquavella JV. Morphology of graft endothelium and donor age. *Br J Ophthalmol* 1980;64:523-7.

[10] Laule A, Cable MK, Hoffman CE, Hanna C. Endothelial cell population changes of human cornea during life. *Arch Ophthalmol* 1978; 96: 2031-5.

[11] Matsuda M, Yee RW, Edelhauser HF. Comparison of the Corneal Endothelium in an American and a Japanese Population. Arch Ophthalmol 1985; 103:68-70.

[12] Snellingen T, Shrestha BR, Gharti MP, et al. Socio-economic barriers to cataract surgery in Nepal: the south Asian cataract management study. *Br J Ophthalmol* 1998;82:1424-28.

[13] The South Asian Cataract Management Study Group. The South Asian Cataract Management Study. I. The first 662 cataract surgeries: a preliminary report. *Br J Opthalmol* 1995;79:1029-35.

[14] Snellingen T, Shrestha JK, Huq F, Husain R, Koirala S, Rao GN, Pokhrel RP, Kolstad A, Upadhyay MP. The South Asian Cataract Management Study: Complications, Vision Outcomes, and Corneal Endothelium Cell Loss in a Randomized Multicenter Clinical Trial Comparing Intracapsular Cataract Extraction With and Without Anterior Chamber Intraocular Lens. Ophthalmology 2000;107:1-10.

[15] Vecchi M, Braccio L, Orsoni JG. The Topcon SP 1000 and Image-NET Systems: A comparison of four methods for evaluating corneal endothelial cell density. *Cornea* 1996;15:271-7.

[16] Price NC, Cheng H. Contact and noncontact specular microscopy. Br J Ophthalmol 1981;65:568-74.

[17] Ohno K, Nelson LR, McClaren JW, Hodge DO, Bourne WM. Comparison of recording and analysis methods in specular microscopy. 1999;18:416-23.

[18] Bourne WM, Nelson LR, Hodge DO. Central corneal endothelial changes over a ten year period. Invest Ophthalmol Vis Sci 1997;38:779-82.

Table 1. Reproducibility of corneal endothelial cell measurements

	no of pairs	mean	mean difference (sd)	CV*
Cell Density				
Between observers	90	2460.7	9.8 (181.1)	5.2
Within observers	60	2450.7	-79.1 (222.5)	6.4
Cell Size Variability				
Between observers	90	42.79	3.53 (8.57)	14.2
Within observers	60	42.51	0.55 (7.05)	11.7
Cell Hexagonality				
Between observers	90	43.47	-0.76 (15.7)	25.5
Within observers	60	43.80	-1.63 (18.5)	29.8

*coefficient of variation of differences =100 * s/x: s= standard deviation of arithmetic difference between measurements/square root of 2; x =mean value of corneal endothelial cell measurement.

Table 2. Distribution of cell density, cells size variability and cell hexagonality by sex and ethnic group

		Cell Density (sq mm)	Cell Size Variability(%)	Cell Hexagonality(%)
	n	Mean (SD)	Mean (SD)	Mean (SD)
Nepali	302	2634 (386)	39. 3 (7.4)	34.4 (7.0)
male	127	2586 (379)	40.0 (7.6)	33.6 (6.9)
Female	175	2670 (388)	39.8 (7.2)	34.9 (7.0)
Between sexes*		p = 0.0617	P = 0.17	P = 0.10
Bangladeshi	464	2782 (342)	33.2 (5.7)	37.8 (5.8)
male	295	2754 (337)	34.1 (6.0)	36.9 (5.6)
Female	169	2830 (345)	31.6 (4.8)	39.4 (5.6)
between sexes*		p=0.02	p < 0.01	p= 0.000005
south Indian	469	2714 (360)	41.3 (6.4)	45.2 (8.9)
male	188	2628 (370)	41.9 (6.6)	43.5 (8.8)
Female	281	2773 (342)	41.0 (6.3)	46.4 (8.7)
between sexes*		p = 0.000016	p=0.11	p < 0.000471
All	1235	2720 (364)	37.8 (7.4)	40.0 (8.6)
male	610	2680 (364)	37.7 (7.4)	38.0 (8.0)
Female	625	2760 (361)	37.8 (7.3)	41.0 (9.0)
between sexes†		p = 0.0001	p = 0.8	P< 0.000001
between ethnic groups‡		p< 0.00001	p< 0.00001	p< 0.00001

*test between sexes in each population group adjusted for age † test between sexes in total population adjusted for age and ethnic groups ‡test between ethnic groups adjusted for age and sex.

Table 3. Mean cell density, cell size variability and cell hexagonality by age

Age Group		Density (sq mm)		Size Variability (%)		Hexagonality (%)	
	n	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
40-49	70	2780 (340)	1713-3517	34.3 (6.3)	22-55	37.4 (6.3)	23 -50
50-59	345	2715 (342)	1478 - 3887	37.5 (7.0)	23 -62	40.2 (8.6)	17-71
60-69	600	2729 (380)	1144-3780	37.8 (7.4)	20-67	40.0 (8.5)	15-80
70-75	220	2684 (361)	1537 - 3469	39. 3 (7.7)	25-80	39.3 (9.3)	18-78
p value*		$p = 0.12$		$p < 0.001$		$p < 0.4$	

*test between age groups adjusted for sex and ethnic group

Table 4.Correlation between cell density, cell size variability (CV) and cell hexagonality

	Correlation coefficient r (95% CI)	Z	p value
Cell density and CV	-0.06 (-0.12 , -0.01)	-2.25	0.02539
Cell density and Hexagonality	0.11 (0.05,0.16)	3.89	0.00013
Hexagonality and CV	-0.20 (-0.25 , -0.14)	-7.09	< 0.00001

Paper III

Table 1 Surgical routines

Treatment	Centre 1	Centre2	Centre 3
Topical antibiotics	Chloramphenicol 6 hourly 24 hours before surgery	Chloramphenicol 6 hourly 72 hours before surgery	None
Anaesthesia			
Retrobulbar	Xylocaine 2 ml	Xylocaine 3·5 ml	Xylocaine* 6 ml
Facial block	Xylocaine 5 ml	Xylocaine 1·5 ml	Xylocaine* 3 ml
Pressure reduction	Weight balance 5–10 minutes	Weight balance 5 minutes	Pinky weight 20 minutes
Sutures (corneoscleral)	5–7 (9/0–10/0 mono-filament)	5 (9/0–10/0 mono-filament)	7 (10/0 mono-filament)
Subconjunctival injections	Gentamicin 0·5 ml (20 mg), Dexamethasone 0·5 ml (2 mg)	Gentamicin 0·5 ml (20 mg), Dexamethasone 0·5 ml (2 mg)	Gentamicin 0·5 ml (20 mg), Dexamethasone 0·5 ml (2 mg)

*+2% adrenaline with Hylase.

gives comparable results to ECCE with implantation of PC IOL in primary cataract surgery.[19 20]

From south Asia data are available on the outcomes of ICCE without implantation of IOL but no study to date has reported on outcomes of ICCE with the modern generation AC IOL lenses. The main purpose of this study was to compare the results of ICCE using a modern AC IOL implant with ICCE with aphakic spectacle correction in clinical settings of south Asia. The main outcome is visual acuity after 2 years of follow up. This paper presents surgical complications and short term outcomes of the first 662 surgical procedures.

Patients and methods

STUDY DESIGN

The South Asian Cataract Management Study (SACMS) is a multicentre randomised controlled clinical trial. Patients are assigned to two treatment groups: (1) ICCE with implantation of a multiflex four point fixation AC IOL (referred to as 'IOL group'). (2) ICCE and no IOL implantation (referred to as 'no IOL group').

The participating centres were: the Department of Ophthalmology, Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu in collaboration with the Mid-Western Eye Care Programme, Nepal Netra Jyothi Sangh, Nepal (centre 1); the Institute of Community, Ophthalmology, University of Chittagong and the Chittagong Eye Infirmary and Training Complex, Bangladesh National Society for the Blind, Bangladesh (centre 2); the LV Prasad Eye Institute, Hyderabad, India (centre 3). All centres followed the same protocol for patient inclusion and follow up. Data were collected preoperatively at inclusion, discharge, 6 weeks, 12 months, and a final evaluation at 24 months after surgery. In Nepal the study was conducted in a rural eye hospital of the mid western development region. In India and Bangladesh the participating institutions were national/regional surgical training centres.

Table 2 Preoperative mean (SD) of age, intraocular pressure, and corneal endothelial cell density by centre

	Centre 1 (n=229)	Centre 2 (n=300)	Centre 3 (n=133)	All (n=662)	p Value*
Age (years)	60 (8·5)	60 (7·7)	61 (7·1)	60 (7·9)	0·40
Intraocular pressure (mm Hg)					
Right eye	14·9 (2·5)	16·1 (2·2)	13·6 (2·7)	15·1 (2·6)	<0·01
Left eye	14·8 (2·4)	16·0 (2·3)	13·6 (2·7)	15·2 (2·6)	<0·01
Inclusion eye	14·9 (2·5)	16·0 (2·2)	13·5 (2·8)	15·1 (2·6)	<0·01
Cell density (cells/mm²)	2708 (356)	2795 (330)	2721 (413)	2750 (359)	>0·5

*Analysis of variance (ANOVA) was used for age and IOP; Kruskal-Wallis test for cell density.

PATIENT RECRUITMENT AND ELIGIBILITY

All patients between 40 and 75 years were eligible if they had visual acuity equal to and less than 6/60 or minimum of perception of light in three out of four quadrants of visual fields in both eyes owing to senile cataract grade 2B and 3 according to Mehra and Minassian.[21] The patients were recruited either through peripheral screening camps or outpatient clinics.

EXCLUSION CRITERIA

Excluded were patients with glaucoma and or intraocular pressure >26 mm Hg; acute or chronic corneal disease; shallow anterior chamber (evidence of iridocorneal contact); chronic iris disease or iris defect; anterior synechiae, traumatic, or complicated cataract; suspected non-lenticular axial high myopia; one eyed and or aphakic; diabetic retinopathy; chronic or severe systemic disease likely to cause death within 3 years.

SAMPLE SIZE AND RANDOMISATION PROCEDURE

The study was designed with a power of 90% ($\beta=0{\cdot}10$) to detect a twofold difference of poor visual outcome (visual acuity less than 6/18 with best possible correction) using a significance level of 5%. It was assumed that the proportion of patients with poor outcome at the end of the study in traditional ICCE with aphakic spectacle correction was 5%. Assuming a 10% loss of cases because of death, 1500 cases were included in the study. Block randomisation was done by using computer generated random numbers. After a patient was included in the study, a sealed envelope was opened with instruction of lens implantation or no lens implantation.

SURGERY

Cilco single piece Kelman Multiflex MT/MTA anterior chamber lenses were used. Determination of IOL power was based on clinical judgment in centre 1 and A-scan in the other centres. The surgical routines are described in Table 1. All surgery was performed with the assistance of an operating microscope with

Table 3 Preoperative mean (SD) of age, intraocular pressure, and cell density by study groups

	Study (n=662)		*IOL (n=343)*		*No IOL (n=319)*		*p Value**
	Mean (SD)	*Range*	*Mean (SD)*	*Range*	*Mean (SD)*	*Range*	
Age	60 (7·9)	40–75	61 (8·0)	40–75	60 (7·8)	40–75	0·19
Intraocular pressure (mm Hg)	15 (2·6)	6–20	15 (2·6)	6–20	15 (2·7)	8–20	0·85
Cell density (cells/mm²)	2750 (359)	1408–3629	2754 (361)	1408–3567	2749 (341)	1478–3629	0·95

*Student's *t* test.

4–10× magnification. It was recommended that the surgeon should have performed at least 100 ICCE and at least 20 AC IOL implantations before being accepted as a participating surgeon in the study. Before the commencement of the study surgeons from two centres participated in a 5 day clinical workshop where surgical techniques of AC IOL insertion after ICCE were demonstrated and practised. The surgeons were recommended to keep surgical manipulation and the use of intraocular fluids and viscoelastics to a minimum. All surgeons use the technique of ab externo corneoscleral section and cryo-assisted extraction of the crystalline lens.

DOCUMENTATION

Basic documentation included detailed history, determination of visual acuity, slit-lamp biomicroscopy, applanation tonometry, and fundus examination. Details of surgical procedure, immediate postoperative complications, and status at discharge were recorded on all cases. Postoperative events including surgically related complications and reactions needing surgical or medical intervention were recorded on separate treatment cards. Intraocular pressures were registered with calibrated Haag-Streit applanation tonometers.

Table 4 Surgical procedure by study groups

	Study total (n=662) (%)	*IOL (n=343) (%)*	*No IOL (n=319) (%)*	*p Value*
Anaesthesia				0·46*
Retrobulbar block	529 (79·9)	272 (79·3)	257 (80·6)	
Peribulbar block	133 (20·1)	71 (20·7)	62 (19·4)	
IOP reduction				0·96*
Digital	9 (1·4)	5 (1·5)	4 (1·3)	
Balloon	111 (16·8)	57 (16·6)	54 (16·9)	
Weight balance	542 (81·9)	281 (81·9)	261 (81·8)	
Section				0·95*
Corneal	12 (1·8)	6 (1·7)	6 (1·9)	
Corneoscleral	643 (97·1)	333 (97·1)	310 (97·2)	
Scleral	7 (1·1)	4 (1·2)	3 (0·9)	
Extraction				0·45*
Cryo	640 (96·7)	335 (97·9)	305 (95·6)	
Forceps	3 (0·5)	2 (0·6)	1 (0·3)	
Tumbling	19 (2·9)	6 (1·7)	13 (4·1)	
Solutions				
Viscoelastic	52 (7·9)	49 (14·3)	3 (0·9)	<0·01†
Ringer's lactate	148 (22·4)	75 (21·9)	73 (22·9)	0·81*
Balanced salt solution	6 (0·9)	3 (0·9)	3 (0·9)	1·00†
Intraocular pilocarpine solution	84 (12·7)	72 (21·0)	12 (3·8)	<0·01*
Sheet's intraocular lens glide	204 (30·8)	204 (59·5)	0	

*χ^2 with continuity correction. †Fisher's exact test.

Table 5 Surgical complications by study groups

	Study total (n=662) n (%)	*IOL (n=343) n (%)*	*No IOL (n=319) n (%)*	*p Value**
Implantation not attempted		6 (1·7)		
Aborted implantations		6 (1·7)		
Patients with complications	103 (15·6)	58 (16·9)	45 (14·1)	0·37
Iris dialysis	9 (1·4)	5 (1·5)	4 (1·3)	0·91
Capsular rupture	40 (6·0)	21 (6·1)	19 (6·0)	0·95
Vitreous loss (all)	51 (7·7)	30 (8·7)	21 (6·6)	0·37
Unplanned ECCE	13 (2·0)	7 (2·0)	6 (1·9)	0·89

*χ^2 with continuity correction.

VISUAL ASSESSMENTS

All visual assessments were performed using standard 60 W×2 illuminated vision boxes with Snellen optotypes at 6 metres. At the 6 week follow up patients were tested with best possible spherical and cylindrical correction (BPC). A second level of vision, the patients' best available correction (BAC), was tested at 1 and 2 year follow up examinations. For the BAC the IOL cases were tested without correction and no IOL (aphakic) cases were tested with +10 spherical correction.

IMAGE DOCUMENTATION

The Topcon IMAGEnet digital imaging system Cellsoft Version 3·5 was used for image documentation and analysis. Patient identification was secured with image ID portraits taken preoperatively and at each follow up examination using a Canon RC-260 ion still video camera and transferred to the computer. In addition, a standard portrait identification for patient ID card and folder was made using a Polaroid mini-portrait camera.

Image documentation of the anterior segment and corneal endothelium cells was secured with a Sony XC77CE single chip high resolution black and white video camera mounted on a Topcon SL-7F slit-lamp. The anterior segment images were taken with the slit-lamp set at 10× magnification. One or more images were captured using the flash acquisition menu of the software program and were subsequently kept for review together with the ID image.

One image is selected and stored together with the ID image on the 200 MB hard disk of the computer. Corneal endothelial cell images (each image includes about 500 cells) were taken using a non-contact specular microscope attached to a SL-7F photo slit-lamp set at 25× magnification (total image magnification 280×). Several images were reviewed before the best image was saved on the hard disk. The images were recalled later and analysis was performed with the automated cell analysis program. Each analysis included about 100 cells. At the end of the day the image files were copied to 940 MB optical cartridges and stored as backup. The same routine of image documentation was done for the preoperative examination and the three scheduled follow up examinations.

ETHICAL CONSIDERATIONS

The study protocol was reviewed and approved by the local ethics or other appropriate committee of each centre and the coordinating institution, according to guidelines set out in the Helsinki Declaration. Each patient was given an appropriate explanation of details of

Table 6 Postoperative complications and reactions at 6 weeks of follow up

	Study total (n=643) n (%)	IOL (n=334) n (%)	No IOL (n=309) n (%)	p Value*
Iritis	12 (1·9)	11 (3·0)	1 (0·3)	0·01
Hyphaema	9 (1·4)	6 (1·8)	3 (1·0)	0·30
Pupil block glaucoma	3 (0·5)	3 (0·9)	0	0·10
Iris prolapse	5 (0·8)	3 (0·9)	2 (0·6)	1·00
Retinal detachment	2 (0·3)	0	2 (0·6)	0·23
Total complications	31 (4·8)	23 (6·9)	8 (2·6)	0·02

*χ^2 with continuity correction and Fisher's exact test.

the study according to guidelines set out in the study protocol. A signed consent (signature or thumbprint) was secured from each participant. An international committee reviewed the data for quality and consistency and based on predefined stopping rules monitored the adverse reactions.

DATA MANAGEMENT AND ANALYSIS

Patient registration, basic documentation, and management of patient flow were secured with a dedicated database. The daily coordination and monitoring of the study was undertaken by a regional office that reviewed and collated the data of the participating centres. Each centre was visited three to four times a year by the project coordinator and all image documentation was reviewed and cross checked with the database using a grid system. Multiple logistic regression analysis using the SPSS PC+ version 4.0 was done to determine possible association of preoperative patient characteristics, surgical procedure, intraoperative surgical complications, and operative complications to visual outcome. Variables that demonstrated a significant effect on outcome were included in a regression model to evaluate their relative risks. EPI INFO Version 5.01b was used for generation of frequency distributions, 2×2 tables, and means. Parametric and non-parametric statistical analyses were used based on the distribution of the data. Analysis of continuous variables between two groups was tested using two sample Student's *t* test for normally distributed data and analysis of variance (ANOVA) for differences of more than two groups. For non-parametric data the Wilcoxon rank sum test was used for comparisons between two groups and the Kruskal-Wallis test was used for analysis of difference between more than two groups. Categorical variables were tested with the χ^2 test with continuity correction or Fisher's exact test. The data were analysed on basis of intention to treat.

STUDY POPULATION

The study population consisted of 662 cases (343 men and 319 women); 318 (48·0%) patients were bilaterally blind (visual acuity less than 3/60 in better eye). Tables 2 and 3 shows mean age, intraocular pressures, and corneal endothelial cell densities by participating centres and study groups respectively. Except for a statistically significant difference in mean intraocular pressure between participating centres there was no significant difference between mean age or corneal endothelial cell counts between centres or between study groups.

Results

A total of 662 surgical procedures were performed with intracapsular cataract surgery between January 1993 and June 1994. No lens extraction was aborted because of complications: 343 (52%) patients were randomised to IOL and 319 (48%) patients were randomised to no IOL. Thirteen surgeons performed an average of 51 (SD 7·4) surgical procedures. On average each surgeon performed equal numbers of the two types of operations.

There was no significant difference of the surgical routines used between the study groups (Table 4). Of the 343 eyes randomised to the IOL group 331 (97%) IOLs were successfully

Table 7 Mean corneal endothelium cell density and percentage cell loss by study group at 6 week follow up

	Cell density (cell/mm²)				Cell loss (%)		
	IOL		No IOL		IOL	No IOL	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Mean (SD)	p Value*
Preoperative	n=333 2748 (373)	1408–3567	n=307 2755 (341)	1502–3629			
Postoperative							
All	n=333 2235 (468)	573–3431	n=307 2308 (446)	852–3197	18·5 (13·6)	16·1 (12·5)	0·05
Uncomplicated surgery	n=275 2243 (469)	573–3431	n=266 2327 (422)	1141–3197	18·1 (13·5)	15·5 (11·4)	0·05
Complicated surgery	n=58 2203 (469)	673–3225	n=41 2190 (567)	852–2918	20·5 (14·0)	20·4 (17·4)	0·97

*Two sample Student's *t* test and Kruskal-Wallis test.

Table 8 Mean cell density and percentage cell loss by complication at 6 week follow up

	Postoperative cell density (cell/mm²)				Postoperative cell loss (%)		
	Complications		No complications		Complications	No complications	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Mean (SD)	p Value*
Intraoperative	n=98 2197 (511)	673–3225	n=542 2284 (448)	573–3431	20·5 (15·4)	16·9 (12·6)	0·05
Postoperative	n=31 2224 (410)	1371–3267	n=609 2273 (461)	573–3431	17·2 (10·9)	17·4 (13·3)	0·92

*Two sample Student's *t* test and Kruskal-Wallis test.

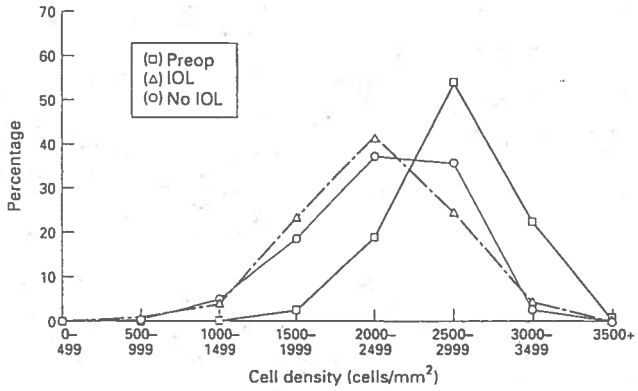


Figure 1 Preoperative and postoperative distribution of corneal endothelium cell density.

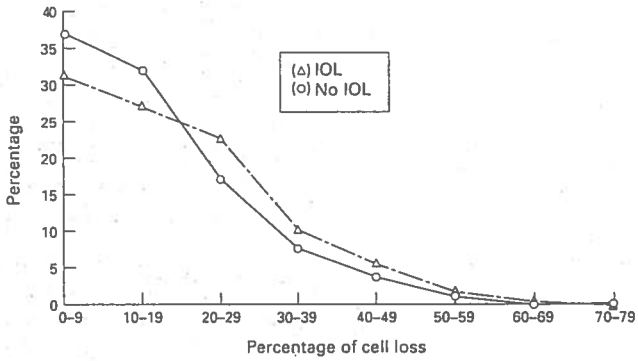


Figure 2 Percentage of corneal endothelium cell loss 6 weeks after surgery.

implanted. In six (1·7%) complicated operations IOL implantation was not attempted because of a surgically related complication. In six (1·7%) procedures lens implant was attempted but aborted because of a complication during the attempt of IOL insertion (Table 5). Table 5 gives the rate of surgical complications. Vitreous loss was the most frequent surgical complication followed by plain capsular rupture, unplanned extracapsular extraction, and iris dialysis. There was no significant difference in the complication rates between study groups.

Of the 662 operations included in this first series 643 patients had been examined at the first follow up schedule (IOL 333, no IOL 310). Three cases (0·5%), all in the IOL group, were lost to follow up because of death; 16 (2·4%) cases were still not examined at the 6 week follow up schedule. At 6 weeks of follow up 31 (4·8%) immediate and short term postoperative complications had been reported (Table 6). The cumulative rate of postoperative complications was significantly higher in the IOL group (p=0·01) owing to moderate iritis that needed prolonged use of local steroids. Moderate iritis represented 38·7% of total complications, followed by hyphaema (29·0%). Two patients, both in the no IOL group, developed retinal detachment. The relative risk of postoperative complication after lens implantation was 2·7 (95% CI=1·2–5·9) compared with ICCE without implantation of an AC lens (Table 6).

Of the 641 slit-lamp microscopic observations of study eyes 128 eyes (20%) showed ovaling of the pupil. This was the only observation that showed a statistically significant difference between groups (relative risk (RR)=4·0, 95% CI=2·5–6·5). One patient had dislocation of the IOL (0·3%) with the inferior haptique of the IOL luxated behind the iris. At 6 weeks mean intraocular pressure was 12 mm Hg in both groups (range 4–21). Two patients in the IOL group had a transient pressure rise, one patient in the immediate postoperative period, the other at 1 month. Three patients (1·0% of IOL cases) needed secondary surgical intervention because of acute pupil block glaucoma.

Tables 7 and 8 summarise the endothelial cell data between study groups at 6 weeks of follow up. A total of 640 (96·6%) corneal endothelial cell images were available for analysis. Mean cell loss was 17·4% (SD 13·4). The IOL group had a 2·5% greater cell loss than the no IOL group (p=0·05). Patients with intraoperative complications had a significantly higher percentage cell loss compared with those without complications. There was no difference between study groups. Only four patients had cell counts less than 1000. The mean corneal endothelial cell loss in these patients was 45% (Figs 1 and 2).

Six weeks after surgery we found that 89% had normal vision using WHO categories (Table 9). There was no significant difference between study groups. The effect of age, sex, preoperative vision, preoperative intraocular pressure, endothelial cell densities, surgical procedure, surgical complications, participating centre, and type of surgery on visual outcome were examined with multiple logistic regression. Only exposure to intraoperative and postoperative surgical complications was

Table 9 Preoperative visual acuity of induction eye and distribution by study group at 6 week follow up

Preoperative			*Postoperative IOL WHO category*					*No IOL WHO category*				
Visual acuity inclusion eye	*WHO* category*		*0*	*1*	*2*	*3*	*4–5*	*0*	*1*	*2*	*3*	*4–5*
6/6–6/18	0	•	•	•	•	•	•	•	•	•	•	•
6/24–6/60	1	31 (4·8%)	89·5%	10·5%	•	•	•	91·7%	8·3%	•	•	•
3/60	2	58 (9·0%)	87·1%	12·9%	•	•	•	88·9%	7·4%	•	3·7%	•
1/60	3	212 (33%)	86·3%	12·7%	•	1·0%	•	90·9%	6·4%	•	1·8%	0·9%
Perception of light	4	342 (53·2%)	89·0%	9·9%	0·5%	0·5%	•	89·4%	8·1%	0·6%	1·9%	•
No perception of light	5	•	•	•	•	•	•	•	•	•	•	•
All	0–5	643	88·0%	11·1%	0·3%	0·6%	•	90%	7·4%	0·3%	1·9%	0·3%

*WHO categories BPC operated eye; 1–5=principal outcome: poor vision <6/18 with best possible correction.

Table 10 Age and sex adjusted risk factors for poor visual outcome 6 weeks after surgery*

	Odds ratio	*95% CI†*	*p Value*
Intraoperative complications	3·1	1·7–5·6	<0·01
Postoperative complications	4·4	1·8–10·2	<0·01

*Visual acuity <6/18. †CI=confidence interval. N=643.

related to increased risk of poor vision (Table 10).

Discussion

The visual outcomes were comparable with the results of intracapsular cataract surgery in this setting.[22 23] The overall rate of postoperative complications was higher in the IOL group (6·9%). This was mainly due to a higher rate of persistent mild iritis (3·0%) needing prolonged use of local steroids. This finding did not qualify as a reason for stopping the trial and is comparable with that reported in a recent survey of short term outcomes of cataract surgery in the UK.[24] Despite our efforts to reduce variability of surgical complications with introduction of minimum entry criteria for participating surgeons we found that one centre had a considerable variability of vitreous loss between surgeons. Despite this caveat there was no significant difference in intraoperative surgical complications between the study groups. In the analysis of corneal cell data we found a small, but statistically significant, greater mean cell loss in the IOL group (p=0·05). This finding is probably related to the increased surgical manipulation of the IOL insertion. There was only a relatively modest increase in mean cell loss in the group of complicated surgeries (2·6%) compared with the non complicated cases. There was no difference between study groups. In the only randomised clinical study with cell data reported,[25] a group of 74 patients with plain ICCE without IOL implantation had a mean cell loss of 10·7% compared with our ICCE no IOL group of 16·1%. The ECCE group (n=74) had a comparable rate of cell loss to our IOL group.

We have reported an interim analysis of the short term outcomes of the only multicentre study of cataract surgery in south Asia. Based on the analysis from this study, which includes surgeons with a wide variability of surgical skills, the introduction of AC IOL does not significantly increase the rate of intraoperative surgical complications. Although small in number and for the majority cases of mild iritis, we did find a significant increase in postoperative reactions in the IOL group compared with the no IOL group. However, this difference is not reflected in the short term visual outcome between groups. The distribution of visual outcomes and corneal endothelial cell loss is similar in both groups at the 6 week follow up. Analysis of 1 and 2 year follow up should give definite conclusions on long term visual outcomes and corneal survival.

The development of protocol has been undertaken in consultation with the Oxford Cataract Treatment and Evaluation team (OCTET), Oxford Eye Hospital, University of Oxford, the Epidemiology Unit of the International Centre for Eye Health (ICEH), Institute of Ophthalmology, University of London and the Centre for Intraocular Lens Research, Storm Eye Institute, Medical University of South Carolina.

The SACMS would like to express its appreciation to Alcon International for its generous donation of intraocular lenses, to the Visitec Corporation for donation of lens glides, and to Topcon Europe for its technical support.

The SACMS is supported financially by the Norwegian Universities Council's Committee for Development Research and Education (NUFU), the Norwegian Research Foundation (NFR), and the Institutes of Clinical and Community Medicine and Faculty of Medicine, University of Tromsø (UiTø), Norway.

A special thanks to Ruth Bjøm and Bjørg Hunstad at the Institute of Community Medicine, University of Tromsø for their dedication and hard work in relation to project administration.

1 Pizarello L. Intraocular lens use in developing countries. *Ophthalmic Surg* 1989; 20: 240.
2 Pizarello L, Ellwin LB. The choice of cataract surgical techniques in developing nations: operations research considerations. *Int Ophthalmol* 1990; 14: 147–54.
3 Young PW, Schwab L. Intraocular lens implantation in developing countries: an ophthalmic surgical dilemma *Ophthalmic Surg* 1989; 20: 241–4.
4 Khosla PK. *Community ophthalmology: an Indian perspective.* New Delhi: Current Scientific Literature, 1992: 113–20.
5 Apple DJ, Solomon KD, Tetz MR, Assia EI, Holland EY, Legler UFC, *et al.* Major review: posterior capsule opacification. *Surv Ophthalmol* 1992; 37: 73–116.
6 Civerchia L, Apoorvananda SW, Natchiar G, Balent A, Ramakriahnan R, Green D. Intraocular lens implantation in rural India. *Ophthalmic Surg* 1993; 24: 648–52.
7 Wright PL, Wilkinson CP, Hal D, Balyeat MD, Popham J, Reinke M. Angiographic cystoid macular oedema after posterior chamber lens implantation. *Arch Ophthalmol* 1988; 106: 740–4.
8 Kraff CM, Sanders DR, Jampol LM, Lieberman HL. Effect of primary capsulotomy with extracapsular surgery on the incidence of pseudophakic cystoide macular oedema. *Am J Ophthalmol* 1984; 98: 166–70.
9 Javitt JC, Tielch JM, Canner JK, Kolb MM, Sommer A, Steinberg EP. National outcomes of cataract extraction. Increased risk of retinal complications associated with Nd:YAG laser caposulotomy. *Ophthalmology* 1992; 99: 1487–98.
10 World Health Organisation. *Available data on blindness (update 1994).* Geneva: WHO/PBL/94.38.
11 World Health Organisation. *Global data on blindness – an update.* Geneva: WHO/PBL/94.40.
12 Apple DJ, Brems RN, Park RB, Norman DK, Hansen SO, Tetz MR, *et al.* Anterior chamber lenses. Part I: Complications and pathology and a review of designs. *J Cataract Refract Surg* 1987; 13: 1257–74.
13 Apple DJ, Hansen SO, Richards SC, Ellis GW, Kavka-Van-Norman D, Tetz MR, *et al.* Anterior chamber lenses. Part II: A laboratory study. *J Cataract Refract Surg* 1987; 13: 1275–89.
14 Lim ES, Apple DJ, Tsai JC, Morgan RC, Wasserman D, Assia EL. An analysis of flexible anterior chamber lenses with special reference to the normalized rate of lens explantation. *Ophthalmology* 1991; 98: 243–6.
15 World Health Organisation. *Report of the consultation on the use of intraocular lenses in cataract surgery in developing countries.* Geneva: WHO, WHO/PBL/91.1.
16 Auffarth UG, Wesendahl TA, Brown SJ, Apple DJ. Are there acceptable anterior chamber intraocular lenses for clinical use in the 1990s? An analysis of 4104 explanted anterior chamber intraocular lenses. *Ophthalmology* 1994; 101: 1913–22.
17 Hassan TS, Kaz SH, Sugar A, Meyer RF. Implantation of Kelman-style, open-loop anterior chamber lenses during keratoplasty for aphakic and pseudophakic bullous keratopathy: a comparison with iris-sutured posterior chamber lenses. *Ophthalmology* 1991; 98: 875–80.
18 Koenig SB, McDermott ML, Hyndiuk RA, Penetrating keratoplasty and intraocular lens exchange for pseudophakic bullous keratopathy associated with a closed-loop anterior chamber intraocular lens. *Am J Ophthalmol* 1989; 108: 43–8.
19 Williamson DE. Incidence of cystoid macular edema and retinal detachment after intracapsular cataract extraction and a modern anterior chamber IOL. Boston: *ASCRS Symposium on Cataract, IOL and Refractive Surgery,* April 8, 1991.
20 Vogel M, Behrens-Baumann W, Petersen J, Quentin CD, Hilgers R, Kron R, *et al.* Vergleich der Komplikationen nach intra- und extrakapsularer Kataraktextraktionen mit Linseimplantation: Ergebnisse einer prospektiven, randomiisierten, klinischen Studie. *Klin Monatsbl Augenheilkd* 1993; 203: 43–52.
21 Mehra V, Minassian DC. A rapid method of grading cataract in epidemiological studies and eye surveys. *Br J Ophthalmol* 1988; 72: 801–3.
22 Reidy A, Mehra V, Minassian D, Mahashabde S. Outcome of cataract surgery in central India: a longitudinal follow-up study. *Br J Ophthalmol* 1991; 75: 102–5.
23 Henning A, Shrestha SP, Foster A. Results and evaluation of high volume intracapsular cataract surgery in Nepal. *Acta Ophthalmol* 1992; 70: 402–6.
24 Desai P. The national cataract surgery survey. II Clinical outcomes. *Eye* 1993; 7: 489–94.
25 Cheng H, McPherson K, Bron AJ. I. Cataract surgery: interim results and complications of a randomised controlled trial. *Br J Ophthalmol* 1986; 70: 402–10.

Appendix

PARTICIPANTS

Investigators: T Snellingen,[4 6] S Gupta,[3] F Huq,[2] J K Shrestha,[1] R Husain,[2] S Koirala,[1] G N Rao.[3]
Surgeons: S Anwar,[2] R K Adhikari,[7] S Basti,[3] S S Gupta,[3] Dhakal,[7] F Huq,[2] S Kutubi,[2] K M Reddy,[3] J K Shrestha,[1] C Tenzing,[3] M Vagh.[3]
SACMS technical staff: M Begum,[2] J Dahal,[1] S Laxmi,[3] S Reddy,[3] R Saha,[2] S Sharma.[1]
Administrators and field coordinators: R Babu,[3] M Gharti,[6] E Hoque.[2]
Computer consultant: E Kureghian,[12] S Upadhyay.[6]
Principal programme administrator: H B Gurung.[6]
Review committee: D J Apple,[10] E Arnesen,[5] H Cheng,[9] E G Olsen,[11] M Vogel.[8]

1 Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu, Nepal.
2 Institute of Community Ophthalmology, University of Chittagong, Bangladesh.
3 LV Prasad Eye Institute, Banjara Hills, Hyderabad, India.
4 Health Systems Research, Institute of Community Medicine, University of Tromsø, Norway.
5 Epidemiology and Medical Statistics, Institute of Community Medicine, University of Tromsø, Norway.
6 SACMS Regional Office, Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu, Nepal.
7 Mid-Western Eye Care Programme, Nepal Netra Jyothi Sangh, Dang, Nepal.
8 Department of Ophthalmology, Universitatsklinik, Gottingen, Germany.
9 Oxford Eye Hospital, University of Oxford, UK.
10 Center for Intraocular Lens Research, Medical University of South Carolina, Charleston, SC, USA.
11 Institute of Clinical Medicine, University of Tromsø, Tromsø, Norway.
12 South Ealing, London, UK.

Paper IV

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

Torkel Snellingen, MD, MPH,[1] Jeevan K. Shrestha, FRCS, FCOphth,[2] Fazlul Huq, DO, MPH,[3] Rabiul Husain, FRCS, FCOphth,[3] Shashank Koirala, MD,[2] Gullapalli N. Rao, MD,[4] Ram P. Pokhrel, FRCS, FCOphth,[5] Albert Kolstad, MD,[6] Madan P. Upadhyay, FRCS, FCOphth[2] Study Review Committee: David J. Apple, MD,[7] Egil Arnesen, MD,[8] Hung Cheng, FRCS, FCOphth[9] (Permanent Members). Erling G. Olsen, MD, PhD,[10] Martin Vogel, MD, PhD[11] (Inclusion Period).

Objective: To determine clinical outcomes of primary intracapsular cataract surgery with and without implantation of anterior chamber lenses.

Design: A multicenter randomized clinical trial.

Participants: One thousand two hundred twenty-nine male and female patients 40–75 years of age with senile cataract.

Methods: Study patients were recruited from screening eye camps and outpatient clinics. Randomization to the two treatment groups was performed after screening for predetermined inclusion and exclusion criteria. Demographics, visual acuity, intraocular pressures, and corneal endothelial cell data were recorded before surgery and at 6 weeks, 12 months, and 24 months after surgery. Monitoring of the study was secured by a standardized image documentation procedure on all patients using the IMAGEnet digital imaging system.

Originally received: December 15, 1998.
Accepted: August 30, 1999. Manuscript no. 98793.

[1] Department of Ophthalmology, Institute of Clinical Medicine and Section for Health Systems Research, Institute of Community Medicine, University of Tromsø, Tromsø, Norway.

[2] B.P. Koirala Lions Centre for Ophthalmic Studies, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal.

[3] Institute of Community Ophthalmology, Chittagong University, Chittagong, Bangladesh.

[4] L.V. Prasad Eye Institute, Hyderabad, Andhra Pradesh, India.

[5] Nepal Eye Hospital, Kathmandu, Nepal.

[6] Norwegian Association for the Blind and Partially Sighted, Oslo, Norway.

[7] Center for Intraocular Lens Research, Storm Eye Institute, Medical University of South Carolina, Charleston, South Carolina.

[8] Epidemiology and Medical Statistics, Institute of Community Medicine, University of Tromsø, Tromsø, Norway.

[9] Oxford Eye Hospital and University of Oxford, Oxford, England.

[10] Department of Ophthalmology, Institute of Clinical Medicine, University of Tromsø, Tromsø, Norway.

[11] Department of Ophthalmology, University of Gottingen, Gottingen, Germany.

Supported by a Norwegian Government Grant, UN Section of the Royal Norwegian Ministry of Foreign Affairs, Norwegian Universities' Council (NUFU) Grant 17/91, and the Faculty of Medicine, University of Tromsø.

Intraocular lenses were donated by Alcon International, and Sheets Glides were donated by the Visitec Corporation.

The authors have no financial or commercial interests in the subject matter or materials mentioned herein.

Address correspondence to Torkel Snellingen, MD, Institute of Community Medicine, University of Tromsø, 9037, Tromsø, Norway.

ISSN 0161-6420/00/$–see front matter
PII S0161-6420(99)00008-1

Analysis of corneal endothelial cell images was performed with the Cell Soft software (Topcon Corporation, Japan).

Main Outcome Measures: Visual acuity and central corneal endothelial cell loss.

Results: The patients were randomized to intraocular lens (IOL; n = 616) and no IOL (n = 613) implantation. Surgical complications were reported in 177 (14.4%) patients (IOL = 14.8%; no IOL = 14.0%). The most frequent complication observed was vitreous loss which occurred in 10.3% of eyes (IOL = 11.2%; no IOL = 9.5%). At the final examination (2 years after surgery), 88% of the operated eyes had a best corrected vision of 6/18 or better (IOL = 88.8%; no IOL = 86.6%). Analysis of corneal endothelial cell data showed a small but significantly greater cell loss 6 weeks after surgery in eyes with IOL compared with those without IOL, but no overall difference was found between the treatment groups in the long term follow-up.

Conclusions: The findings indicate that there is a rationale for the use of anterior chamber intraocular lenses in primary intracapsular cataract surgery. *Ophthalmology 2000;107:231–240*

Worldwide it is estimated that at least 38 million people are blind and that an additional 110 million people have severely impaired vision. Cataracts are the most common cause of blindness. According to global estimates, a backlog of 16 million people with cataract blindness have not received surgery.[1] Because of population growth and aging, this number is increasing. Presently an estimated 7 million cataract operations are performed each year. By the year 2020, 32 million operations must be performed each year if the backlog is to be eliminated.[2] Clearly, the volume of cataract surgery must increase dramatically to keep pace with the increasing number of people with cataract blindness.

The development and implementation of programs for prevention of blindness in many countries[3] has made cataract surgery accessible and affordable to an increasing number of the world's population. In India alone the number of cataract surgeries increased from 500,000 in 1981 to 2.2 million in 1995.[4] Despite the trend toward conversion to extracapsular cataract extraction (ECCE), intracapsular cataract extraction with aphakic spectacle correction (ICCE-AG) is in many settings still the principal form of surgery.[5] It is estimated that in India alone, 50% of all cataract surgery, or 1.2 million operations per year, are being performed with ICCE-AG.[6] The problems related to the visual rehabilitation of ICCE-AG surgery are well known,[7,8] and with the changing trends in the acceptance of intraocular lenses,[9] there is now an understanding that surgeons in both developed and developing countries should be trained in techniques of intraocular lens (IOL) implantation.

Studies have shown that posterior capsular opacification (PCO) is a major complication in ECCE surgery.[10] Posterior capsular opacification does not occur in ICCE surgery, so this technique is well adapted to settings where the availability of YAG lasers is still rudimentary.[11] With a new generation of anterior chamber lenses (AC-IOL) having been shown to be safe,[12–18] the World Health Organization (WHO) recommended that randomized clinical studies be undertaken to compare the two main techniques of cataract surgery with and without IOL implantation in the developing world (World Health Organization. Report of the consultation on the use of intraocular lenses in cataract surgery in developing countries, WHO/PBL/91.1 Geneva 3–7 December, 1990).

In this report we present the clinical outcomes 2 years after surgery of a multicenter randomized clinical trial, the South Asian Cataract Management Study, comparing the outcomes of intracapsular cataract extraction with and without the new generation multiflex AC-IOLs. The main outcomes are vision, long-term complications, and corneal endothelial cell survival.

Patients and Methods

From January 1993 through November 1995, 1237 patients were recruited to participate in a randomized clinical trial from three centers in the South Asian region (Fig 1): the Department of Ophthalmology, Institute of Medicine, Tribhuvan University Teaching Hospital, Kathmandu, Nepal in collaboration with the Rapti Eye Hospital, Mid-Western Nepal (center 1); the Institute of Community Ophthalmology, University of Chittagong at the Chittagong Eye Infirmary and Training Complex, Bangladesh (center 2); and the L.V. Prasad Eye Institute, Hyderabad, Andhra Pradesh, India (center 3). Center 1 is a rural eye hospital that performs primarily ICCE-AG both at the hospital and in eyecamps; center 2

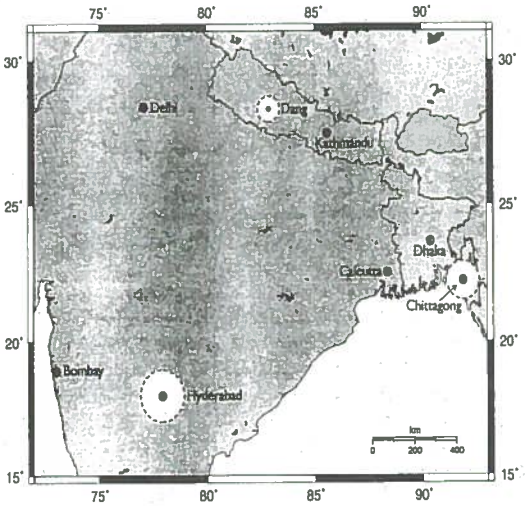


Figure 1. Map of location of participating centers with surrounding study field area in white.

Table 1. Study Inclusion and Exclusion Criteria

	Definition
Inclusion criteria	
Age	40–75 years
Visual acuity	≤6/60 (0.1) better eye with best correction and minimum of perception of light in three of four quadrants
Cataract grading	Senile cataract grade 2B and 3 (Mehra and Minassian[19])
Exclusion criteria	
Glaucoma	Known or suspected glaucoma
IOP	>26 mmHg
Corneal disease	Acute or chronic
Shallow anterior chamber	Evidence of iridocorneal contact
Iris	Chronic iris disease or iris defect Anterior synechiae
Cataract	Congenital, traumatic or complicated
Refraction	Nonlenticular axial high myopia
Other	One eye, aphakic, or both Diabetic retinopathy Disease likely to cause death within 3 years

IOP = intraocular pressure.

is a national and regional training center. In the hospital, ECCE posterior chamber (PC) IOL and ICCE-AG were performed in equal numbers, whereas ICCE-AG was the only procedure undertaken in eye camps. In center 3, all cataract surgery is undertaken at the clinical center, where ICCE is not performed routinely. However, all participating surgeons had some experience in the ICCE technique.

Patients between 40 and 75 years of age with visual acuity equal to or less than 6/60 but a minimum of perception of light in 3 of 4 quadrants of visual fields in both eyes resulting from senile cataracts were eligible for the study. The degree of cataracts was assessed using a grading system.[19] Patients were recruited from eyecamps and outpatient departments.[20,21] Table 1 presents the inclusion and exclusion criteria.

All surgeries were performed at the eye hospital. It was recommended that each surgeon should have performed at least 100 intracapsular cataract extractions and 20 AC-IOL implantations. The surgeons were advised to keep surgical manipulation and the use of intraocular fluids and viscoelastics to a minimum. All surgeons used ab externo corneo-scleral section and cryo-assisted extraction of the crystalline lens. Before the start of the study, surgeons from centers 1 and 2 participated in a 5-day clinical workshop where ICCE with AC-IOL was demonstrated and practiced.

Based on the recommendations of the World Health Organization, Cilco Single Piece Kelman Multiflex four-point MT/MTA anterior chamber lenses (Alcon International, Fort Worth, Texas) were used in the study. All surgeons used an operating microscope with 4× to 10× magnification. Details of surgical procedure, immediate postoperative complications, and status at discharge were recorded for all cases. Postoperative events, including surgically related complications and reactions needing surgical or medical intervention, were recorded on separate treatment cards. Intraocular pressures were registered with calibrated Haag Streit applanation tonometers (Haag Streit, Germany).

Patients were scheduled for follow-up examination at 6 weeks, 12 months, and 24 months after surgery with the 2-year examination as the end point. All the 6-week and 12-month examinations were conducted at the clinical center. Those patients who attended a follow-up more than 3 months after the scheduled 6 weeks were included in the 12-month follow-up and coded as missing the 6-week follow-up. Those patients who attended a follow-up more than 6 months after the 12-month follow-up were included in the final examination and were coded as missing the 12-month follow-up. Those who did not come for final follow-up but had traceable addresses and who complied, were, with their agreement, examined in their homes.

Visual assessments were performed using standard 60-watt-times-2 illuminated vision boxes with Snellen's optotypes at 6 m by the same examiners in centers 1 and 2. In center 3 visual acuities were obtained by optometrists in the outpatient department with a Snellen chart projected by a slide projector. All patients who completed a follow-up examination were tested with the best possible correction.

All centers followed a standardized examination routine including image documentation of anterior segment and corneal endothelium cells. The Topcon IMAGEnet Digital Imaging System Cellsoft Version 3.5 (Topcon Corporation, Tokyo, Japan) was used for image documentation and analysis. Patient identification was secured with identification portraits taken before surgery and at each follow-up examination using a Canon RC-260 ION Still Video Camera (Canon Inc, Japan) and transferred to the computer. In addition, a standard portrait identification for a patient identification card and folder was made using a Polaroid Mini-Portrait Camera (Polaroid Corporation, Tokyo, Japan). Image documentation of the anterior segment and corneal endothelium cells was secured with a Sony (Sony Corporation, Tokyo, Japan) XC77CE single-chip high resolution black and white video camera mounted on a Topcon SL-7F slitlamp (Topcon Corporation, Tokyo, Japan). The anterior segment images were taken with the slitlamp set at 10 times magnification.

Corneal endothelial cell images were taken using a noncontact specular microscope attached to an SL-7F photo slit lamp set at 25 times magnification (total image magnification, times 280). The same routine of image documentation was carried out for the preoperative examination and the three scheduled follow-up examinations. The images were analyzed with a semi-automated technique[22] and has been estimated to have a precision of 94.8% between observers and 93.6% within observers.

For the field examination, vision was tested with a Snellen Vision Chart, and refraction was tested with retinoscopy. The anterior segment was examined with a portable hand-held slitlamp (25% of cases) and torch light (75% of cases). Photodocumentation of the anterior chamber was made with the portable ION camera with images stored on mini disks. Perkins tonometer was used for the measurement of intraocular pressure, and a direct ophthalmoscope was used for the fundus examination.

The study protocol was reviewed and approved by the local ethical or other appropriate committee of each center and the coordinating institution according to guidelines set out in the Helsinki Declaration. Each patient was given an appropriate explanation of details of the study according to guidelines set out in the study protocol. A signed consent (signature or thumbprint) was secured from each participant. An international committee reviewed the data for quality and consistency and monitored adverse reactions.

The study was designed with a power of 90% to detect a twofold difference of poor visual outcome (visual acuity less than 6/18 with best possible correction) between the two treatment groups using a significance level of 5%, assuming a 10% prevalence of poor vision (visual acuity less than 6/18) for the IOL group and a 5% prevalence of poor vision for the no IOL group.

The unit of randomization was the patient. Block randomization was performed with computer-generated random numbers to serially produced sealed opaque envelopes prepared by the aca-

Table 2. Preoperative Means and Standard Deviations of Patient Age, Intraocular Pressure, and Cell Density of Study Eye by Study Groups

	All (n = 1229)	IOL (n = 616)	No IOL (n = 613)	P-Value
Age	60.5 (7.6)	60.8 (7.6)	60.2 (7.6)	0.19
Inclusion eye				
Intraocular pressure (mmHg)	14.8 (2.7)	14.7 (2.7)	14.8 (2.8)	0.60
Cell density (cells/mm^2)	2721 (365)	2733 (363)	2710 (367)	0.26

IOL = intraocular lens.

demic coordinating center (Institute of Community Medicine, Tromsø, Norway). After a patient was included in the study, s/he was assigned a randomization category according to the serial inclusion number. The assignment of study patients was carried out when the patient was prepared for surgery in the operating theater. The sealed envelope was opened with instruction of lens implantation or no lens implantation.

Parametric and nonparametric statistical analyses were used based on the distribution of the data. Analysis of continuous variables between two or more groups were tested using analysis of variance (ANOVA). For nonparametric data, the Wilcoxon rank-sum test was used for comparisons between two groups, and the Kruskal-Wallis test was used for analysis of differences between more than two groups. Categoric variables were tested with the chi-square test or Fisher's exact test. The data were analyzed on basis of intention to treat.

Results

One thousand two hundred thirty-seven patients were included in the study. Six hundred twenty patients were assigned to the IOL group, and 617 patients were assigned to the no IOL group. Eight patients (0.6%; equal numbers in each group) did not undergo surgery after having been assigned to a study group. Table 2 shows the mean preoperative age, intraocular pressure, and central corneal endothelial cell counts. There was no significant difference between study groups.

Figure 2 shows the patient follow-up by study groups. Of the 1229 operated cases, 94% were examined at 6 weeks after surgery. Excluding deaths, 77.1% and 82.3%, respectively, were examined at the 1- and 2-year follow-up. One hundred thirteen patients (9.2%) had died by the 2-year follow-up time. One thousand forty patients (84.6%) had at least one examination 12 months or more after surgery, with a mean follow-up time of 2.1 years. Of these, 1010 (97.1%) were examined in the clinical centers, and the remaining 30 were examined in their home. Table 3 shows the characteristics of those who had completed clinical follow-up compared with cases with no clinical follow-up after 6 weeks. There were no significant differences regarding preoperative data or surgical complications between the two groups.

Surgery

A total of 1229 ICCE operations, 616 (50.1%) with AC-IOL implantation, were performed by 19 surgeons, who performed an average of 45 surgeries (standard deviation [SD] = 4; range, 2–100). Table 4 shows the surgical procedures by study groups. Most surgeons (91.5%) used an ab externo corneoscleral surgical section and cryoextraction (95.2%) of crystalline lens. Except for the use of Sheet's intraocular lens glide (Visitec Corporation) (52.6%), viscoelastics (27.3%), and intraocular pilocarpine (30.2%) in the IOL group, there were no differences in the surgical routines between the study groups.

Table 5 shows the frequency of intraoperative surgical complications and postoperative secondary surgical interventions by study groups. A total of 177 cases (14.4%) had complicated surgery: 91 (14.4%) in the IOL group and 86 (14.0%) in the no IOL group (RR = 1.05; 95% confidence interval [CI] = 0.80–1.38). One patient experienced an expulsive hemorrhage and the surgery was aborted. Twenty-one patients in the IOL group did not receive an IOL as assigned. The most frequent complication was vitreous disturbance resulting in vitreous loss followed by anterior vitrectomy, which occurred in 127 cases (10.3%). We found no differences in intraoperative complications between study groups. Forty eyes (3.3%) needed postoperative surgical intervention. There was a significantly higher frequency of secondary surgery in the IOL group compared with the no IOL group (RR = 2.26; 95% CI = 1.12–4.56).

Postoperative Visual Acuity and Complications

Table 6 shows the distribution of postoperative visual acuity by the different categories of preoperative vision 6 weeks after surgery. With the best possible correction, 88.1% of cases had "normal" vision (6/18 or better). There was a slightly larger percentage of IOL cases with "poor" vision (less than 6/18) than in the no IOL group (RR = 1.39; 95% CI: 1.01–1.92), however, in the IOL group only 1.0% of patients had severe visual impairment or blindness (less than 6/60) compared with 2.6% in the no IOL group ($P = 0.046$).

Table 7 presents best corrected vision by study group in patients with long-term follow-up. Of 1040 cases examined, 87.7% had "normal" vision, 12.3% had "poor vision," and 3.8% had severe visual impairment and blindness. There was no significant difference between the study groups. Of those patients having experienced vitreous loss, 5.4% had severe visual impairment or blindness at the final visual examination. The relative risk of "poor" outcome for this group compared with patients without vitreous loss was statistically significant (RR = 2.66; 95% CI = 1.89–3.74).

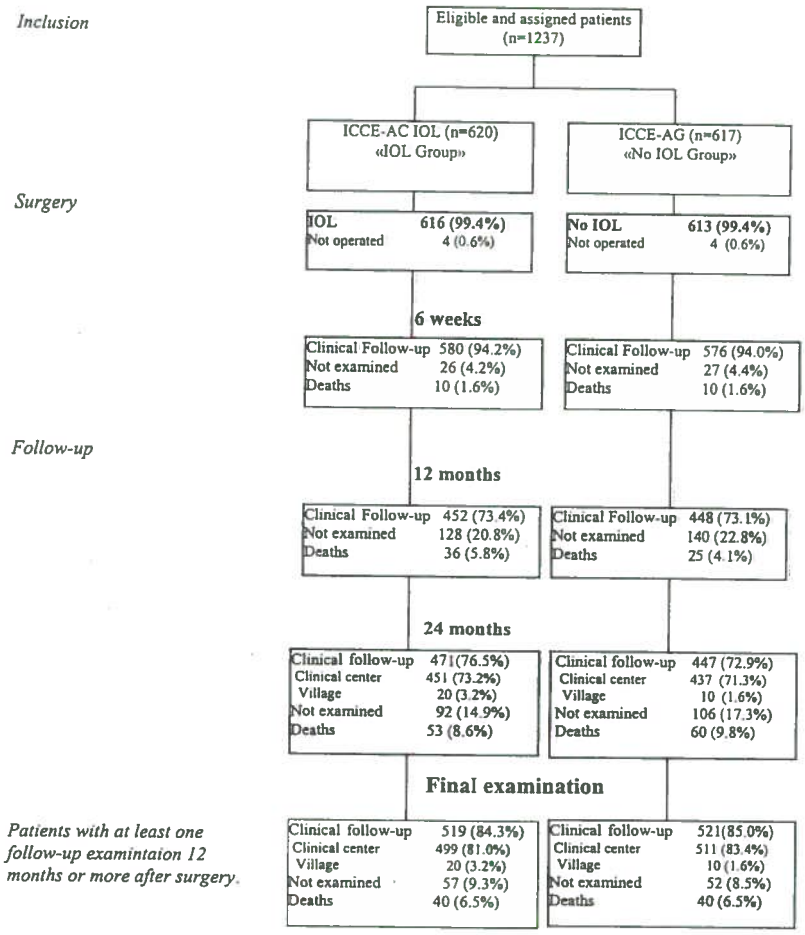


Figure 2. Study flow chart.

Table 8 presents causes of severe vision loss (less than 6/60). Of the 39 eyes (3.8%) with severe visual impairment, 19 (1.8%) resulted from pre-existing eye disease. The most common cause of postoperative, surgically related vision loss was retinal detachment. At the final follow-up, the cumulative rate of retinal detachment was 0.6% (IOL = 0.4%; no IOL = 0.8%). We found no significant differences in IOP between study groups (mean IOP = 13.0 mmHg; SD = 2.6). Secondary glaucoma was reported in two cases (both in the no IOL group); of these, one had severe vision loss. One case of corneal decompensation resulting from dislocation of the lens was found at the 2-year follow-up.

Corneal Endothelial Cell Survival

All patients included in the study had preoperative central corneal endothelial cell data. We found no statistically significant difference in the preoperative cell density between the groups (IOL = 2733 cells/mm^2; SD = 363; no IOL group = 2710 cells/mm^2; SD = 367). For the follow-up examinations, 95.4% of those seen at the clinical centers had corneal endothelial cell data. The surgically related central corneal endothelial cell loss (at 6 weeks) was 15.8% (SD = 13.0). Table 9 presents postoperative percentage of cell loss by study groups at each follow-up in the overall study population, in patients with vitreous complications, and in patients with a preoperative cell count less than 2000.

At the 6-week follow-up we found a greater cell loss in the IOL group (17.0%) compared with the no IOL group (14.4%) ($P < 0.0005$). Patients with vitreous loss had a greater immediate postoperative cell loss, 18.9% compared with 15.4% for other cases ($P = 0.007$), but there was no significant difference between study groups. After 6 weeks, the overall cell loss was 20.3% and 22.9%, respectively, for the 12- and 24-month examinations. There was no significant difference in continuing cell loss between treatment

Table 3. Characteristics of Patients Lost to Follow-up after the 6-Week Examination (12- and 24-Month Follow-up)

	All Examined			IOL Examined			No IOL Examined		
	Yes	*No*	*P*-Value	*Yes*	*No*	*P*-Value	*Yes*	*No*	*P*-Value
Preoperative	n = 1040	n = 189		n = 519	n = 97		n = 521	n = 92	
Mean age (SD)	60.4 (7.6)	61.3 (7.1)	0.13	60.7 (7.7)	60.7 (7.3)	0.78	60.0 (7.6)	62.5 (7.2)	0.004
Mean cell density (SD)	2718 (366)	2740 (359)	0.45	2731 (365)	2743 (353)	0.77	2705 (367)	2735 (366)	0.47
Females	49.6%	56.6%	0.08	47.3%	57.1%	0.09	52.0%	55.4%	0.54
Vitreous disturbance*	9.5%	11.3%	0.50	11.2%	9.0%	0.58	8.3%	13.7%	0.07
Vision (6 wks)	n = 1005	n = 151		n = 502	n = 78		n = 503	n = 73	
Good outcome (visual acuity 6/60 or better)	98.4%	96.7%	0.10	99.4%	96.2%	0.008	97.5%	97.3%	0.74
Severe visual impairment (visual acuity <6/60–3/60)	0.4%	0		0.2%	0		0.6%	0	
Blind (visual acuity <3/60)	1.2%	3.3%		0.4%	3.9%		2.0%	2.8%	

*Any vitreous disturbance leading to vitrectomy.

IOL = intraocular lens.

groups between the 6-week and 12-month follow-up (IOL = 5.3%; no IOL = 4.1%; $P = 0.06$) or between the 12-month or 24-month follow-up (IOL = 3.1%; no IOL = 2.9%; $P = 0.8$; Fig 3). Thirty-eight (3.1%) patients had a preoperative cell density less than 2000 cells/mm^2. Of these, 68.4% were observed for 2 years. The mean cell loss was 21.9%. Two years after surgery, 89 patients (IOL = 47; no IOL = 42), or 10.5%, who completed 2 years of follow-up had a cell density less than 1500 cells/mm^2. The total cell loss for these eyes was 45.6%. There was no significant difference between the study groups.

Discussion

To our knowledge this is the only randomized clinical study with more than 1 year of follow-up comparing ICCE with and without a modern AC-IOL. In the "Lahan" study, Hennig et al[23] followed 1827 cases in which ICCE was used with and without AC-IOL by two surgeons in eastern Nepal. At the 1-year follow-up, 89.9% and 93.2% of patients with and without IOL, respectively, had "normal" vision (visual acuity of 6/18 or better with the best possible correction). Uveitis, secondary glaucoma (unspecified), or both were the

Table 4. Pre- and Intraoperative Routines by Study Group

	All (n = 1229)*	IOL (n = 616)*	No IOL (n = 613)*	*P*-Value
Anesthesia				0.52
Retrobulbar block	785 (63.9)	388 (63.0)	397 (64.8)	
Peribulbar block	444 (36.1)	228 (37.0)	216 (35.2)	
Intraocular pressure reduction				0.79
Digital	149 (12.1)	72 (11.7)	77 (12.6)	
Balloon	202 (16.4)	105 (17.0)	97 (15.8)	
Weight balance	878 (71.4)	439 (71.3)	439 (71.6)	
Section				0.92
Corneal	94 (7.7)	46 (7.5)	48 (7.8)	
Corneoscleral	1124 (91.5)	565 (91.7)	559 (91.2)	
Scleral	11 (0.9)	5 (0.8)	6 (1.0)	
Extraction				0.44
Cryoprobe	1170 (95.2)	591 (95.9)	579 (94.5)	
Forceps	6 (0.5)	3 (0.5)	3 (0.5)	
Tumbling	53 (4.3)	22 (3.6)	31 (5.1)	
Sheet's intraocular lens glide	324 (26.3)	324 (52.6)	0	<0.0001
Viscoelastic	187 (15.2)	168 (27.3)	19 (3.1)	<0.0001
Irrigation fluids				0.66
Ringers lactate	348 (28.3)	180 (29.2)	168 (27.4)	
Balanced salt solution	80 (6.5)	42 (6.8)	38 (6.2)	
No fluids	801 (65.2)	394 (64.0)	407 (66.4)	
Intraocular pilocarpine solution	265 (21.6)	186 (30.2)	79 (12.9)	<0.0001

*Data are n (%).

IOL = intraocular lens.

Table 5. Intraoperative Complications and Postoperative Surgical Interventions by Study Groups

	All (n = 1229)*	IOL (n = 616)*	No IOL (n = 613)*	Relative Risk for IOL (95% CI)
Intraoperative complications†	177 (14.4)	91 (14.8)	86 (14.0)	1.05 (0.80–1.38)
Expulsive hemorrhage	1 (0.1)	0	1 (0.2)	
Iris dialysis	16 (1.3)	7 (1.1)	9 (1.5)	
Vitreous disturbance‡	127 (10.3)	69 (11.2)	58 (9.5)	
Unplanned ECCE	33 (2.7)	15 (2.4)	18 (2.9)	
Postoperative surgical intervention	36 (2.9)	25 (4.1)	11 (1.8)	2.26 (1.12–4.56)
Simple wound closure	10 (0.8)	4 (0.6)	6 (1.0)	
Iris reposition	6 (0.5)	2 (0.3)	4 (0.7)	
Reformation of anterior chamber	5 (0.4)	4 (0.8)	1 (0.2)	
Peripheral iridectomy/iridotomy	9 (0.7)	9 (1.4)	0	
IOL reposition	4 (0.3)	4 (0.6)		
IOL explantation	2 (0.2)	2 (0.3)		

*Data are n (%).

†Aborted implantations = 21 (3.4%).

‡Any vitreous disturbance leading to vitrectomy.

CI = confidence interval; ECCE = extracapsular cataract extraction, IOL = intraocular lens.

most frequent postoperative complications. Retinal detachment occurred in 0.2% of cases, all in the ICCE-AG group. They reported one case of corneal decompensation in the no IOL group. In our study the most common major late postoperative complication was retinal detachment (0.6%), followed by macular edema (0.3%). We found one case of corneal decompensation in the IOL group (0.2%) and two cases of secondary glaucoma, in the no IOL group (0.4%). In the eye with a decompensated cornea, the surgery was uncomplicated but there was suspicion of direct trauma to the globe between 6 weeks and 12 months after surgery that resulted in dislocation of the IOL. In a review of 90 studies on outcomes of all types of cataract surgery,[24] posterior capsular opacification was the most common complication, occurring in from 0.8% to 47.6% of cases. Retinal detachment and clinically apparent cystoid macular edema was observed in 0.6% to 7%, and secondary glaucoma and corneal decompensation were noted in 0% to 0.6%. In ECCE surgery, malposition or dislocation of the IOL has been shown to vary from 0.4% to 4.9%. In the Lahan study,[23] there were no cases of dislocation of the IOL. In the Madurai study,[25] 0.7% of lenses were decentered, 0.1% had malpositioned haptics, and 0.1% had traumatic extrusion of the IOL. In our study, 0.7% of IOL eyes needed secondary repositioning, and 0.3% of IOLs were explanted.

The frequency of surgical complications in our study showed a wide variability, ranging from 0% to 40% between surgeons. One center had a significantly higher intraoperative complication rate (RR = 3.12; 95% CI = 2.34–4.16) and rate of secondary surgical interventions (RR = 2.87; 95% CI = 1.54–5.36) compared with the other two centers. This center had the greatest number of participating surgeons and primary ICCE surgery was not performed routinely. In studies of ECCE surgery in different settings of Africa, Asia, and the Middle East, capsular rupture with or without vitreous loss varied between 1.7% and 10%.[25–29] In our study, the overall rate of vitreous loss was comparatively

Table 6. Pre- and Postoperative Best Corrected Visual Acuity of Inclusion Eye by Study Group at 6-Week Follow-up

Preoperative†			Postoperative: IOL (n = 580)†				Postoperative: No IOL (n = 576)†			
Visual Acuity	*WHO* Category*		*0*	*1*	*2*	*3–5*	*0*	*1*	*2*	*3–5*
6/6–6/18	0	—	—	—	—	—	—	—	—	—
<6/18–6/60	1	59 (5.1)	31 (91.2)	3 (8.8)	—	—	23 (92.0)	2 (8.0)	—	—
<6/60–3/60	2	104 (9.0)	45 (84.9)	7 (13.2)	—	1 (1.9)	46 (90.2)	3 (5.9)	1 (2.0)	1 (2.0)
<3/60–1/60	3	322 (27.9)	136 (87.2)	19 (12.2)	—	1 (0.6)	150 (90.4)	12 (7.2)	1 (0.6)	3 (1.8)
<1/60–Perception of light	4	671 (58.1)	288 (85.5)	45 (13.4)	1 (0.3)	3 (0.9)	300 (89.8)	25 (7.5)	1 (0.3)	8 (2.4)
No perception of light	5	—	—	—	—	—	—	—	—	—
All	0–5	1156 (100)	500 (86.2)	74 (12.8)	1 (0.2)	5 (0.9)	519 (90.1)	42 (7.3)	3 (0.5)	12 (2.1)

*World Health Organization categories of vision.

†Data are n (%).

IOL = intraocular lens.

Table 7. Best Corrected Vision by Study Group at Final Examination (at Least 1 Year Follow-up)

Visual Acuity	WHO Group	All (n = 1040)*	IOL (n = 519)*	No IOL (n = 521)*	Relative Risk for IOL Group (95% Confidence Interval)
6/18 or Better	0	912 (87.7)	461 (88.8)	451 (86.6)	
<6/18–6/60	1	89 (8.6)	38 (7.3)	51 (9.8)	
<6/18	1–5	128 (12.3)	58 (11.2)	70 (13.4)	0.83 (0.60–1.15)
<6/60	2–5	39 (3.8)	20 (3.9)	19 (3.6)	1.06 (0.57–1.96)

*Data are n (%).

IOL = intraocular lens; WHO = World Health Organization.

high (10.3%), with a significant variability between surgeons.

It is clear that, when comparing studies that consider all types of cataract surgery, both intra- and postoperative complications are reported to vary widely. We found that despite the great variation in intraoperative complication rates, there were no significant differences between study groups in the risk of long-term, sight-threatening complications. This was also reflected in the distribution of best corrected vision outcomes, which were not significantly different between the treatment groups.

To our knowledge there are no studies that have documented long-term endothelial cell loss in eyes with the new generation of anterior chamber intraocular lenses. Bates et al[30–32] showed in their studies that the changes that occur in the corneal endothelium after surgery can be accurately modeled to predict corneal endothelial survival after cataract surgery. The rate of postoperative central corneal endothelial cell loss is thus an important predictor for bullous keratopathy. In the Oxford cataract surgery study of 330 eyes, Cheng et al[33] found a continuing cell loss in both aphakic eyes and eyes with IOL up to 5 years after surgery. In the Oxford study, the three study groups showed a continuing cell loss. In one of the IOL groups there was a significant increase in continuing mean corneal endothelial cell loss compared with the no IOL group. By the fourth year, eight corneas had decompensated. In our study, after the initial immediate postoperative period, we found an overall continuing cell loss, but there was no significant difference between the treatment groups. This was also the case for eyes with a low preoperative cell count (<2000 cells/mm^2) and eyes with a low postoperative cell count 2 years after surgery (<1500 cells cells/mm^2).

Since the beginning of the last century, the main surgical treatment of cataracts in developing countries has been intracapsular extraction. The standard surgery in eyecamps is ICCE and is, in this setting, the only method of surgery that is legally permissible in India.[5] There are still major socio-economic barriers to cataract surgery.[21] With the perceived advantages of pseudophakia,[34] IOL surgery, with the subsequent improvement in the quality of vision, has the potential to give benefits that will reduce these barriers.

Table 8. Causes of Severe Vision Loss (Less Than 6/60) at Final Follow-up by Study Group

	All, n (%)	IOL, n (%)	No IOL, n (%)	P-Value
Total number examined	1040	519	521	
Total with poor vision (<6/60)	39 (3.8)	20 (3.9)	19 (3.7)	0.86
Pre-existing disease	19 (1.8)	10 (1.9)	9 (1.7)	0.79
Macular disease/degeneration	10 (1.0)	7 (1.3)	3 (0.6)	
Optic nerve disease/atrophy	5 (0.5)	1 (0.2)	4 (0.8)	
Retinal detachment*	4 (0.4)	2 (0.4)	2 (0.4)	
Surgical complication				
Expulsive hemorrhage	1 (0.1)	0	1 (0.2)	
				Relative risk for IOL (95% CI)
Postoperative complications*	19 (1.8)	10 (1.9)	9 (1.7)	1.10 (0.49–2.46)
Corneal ulcer	1 (0.1)	0	1 (0.2)	
Endophthalmitis	1 (0.1)	0	1 (0.2)	
Corneal edema	1 (0.1)	1 (0.2)	0	
Corneal decompensation/opacification	1 (0.1)	1 (0.2)	0	
Secondary glaucoma	1 (0.1)	0	1 (0.2)	
Posterior capsular opacification†	2 (0.2)	2 (0.4)	0	
Macular edema	3 (0.3)	2 (0.4)	1 (0.2)	
Vitreous hemorrhage/haze/opacity	3 (0.3)	2 (0.4)	1 (0.2)	
Retinal detachment*	6 (0.6)	2 (0.4)	4 (0.8)	

*Four retinal detachments were reported as pre-existing before surgery.

†Patients with unplanned extracapsular cataract extraction.

IOL = intraocular lens.

Table 9. Percentage Corneal Endothelial Cell Loss by Study Group and Follow-up Examination, Mean (SD)

	6 Weeks			12 Months			24 Months		
	IOL	*No IOL*	*P*-Value Between Study Groups	*IOL*	*No IOL*	*P*-Value Between Study Groups	*IOL*	*No IOL*	*P*-Value Between Study Groups
All	n = 577	n = 568		n = 448	n = 437		n = 429	n = 418	
Total cell loss*	17.0 (10.5)	14.4 (12.2)	0.0005	22.2 (13.6)	18.3 (12.7)	<0.0001	25.0 (14.3)	20.8 (14.0)	<0.0001
After 6 wks†				5.3 (9.9)	4.1 (9.7)	0.06	3.1 (9.0)	2.9 (9.3)	0.71
Vitreous disturbance	n = 63	n = 51		n = 52	n = 37		n = 44	n = 35	
Total cell loss*	19.9 (16.4)	17.5 (16.3)	0.45	21.9 (17.6)	21.0 (19.5)	0.82	24.2 (21.1)	20.8 (14.0)	0.80
After 6 wks†				4.6 (10.8)	5.5 (10.5)	0.7	2.8 (11.9)	2.7 (10.2)	0.97
Preoperative cell density less than 2000	n = 14	n = 18		n = 13	n = 20		n = 9	n = 17	
Total cell loss*	20.7 (16.4)	14.1 (12.4)	0.2	24.4 (15.1)	17.5 (14.2)	0.18	0 (12.9)	6.4 (12.9)	0.1
After 6 wks†				5.4 (9.9)	4.1 (9.7)	0.06	5.2 (5.4)	3.9 (8.3)	0.58

*Test between study groups—continuing postoperative cell loss between 6 weeks and 12 months after surgery.

†Test between study groups—continuing postoperative cell loss between 12 months and 24 months after surgery.

IOL = intraocular lens.

Intraocular lenses of high quality are now manufactured in developing countries and are available for a reasonable price ($8–$25 US). However, in settings where most cataracts are mature and hypermature,[35] it is still unclear if the conversion to ECCE with PC-IOL, with the potential for increased intraoperative complications, is the only viable alternative. Economic and logistic constraints also dictate that the potential for permanent visual loss in patients who experience posterior capsular opacification 1 year or more after surgery will continue to be an important consideration in the transition to ECCE surgery. More data are needed on the risk of posterior capsular opacification and its long-term implications in this context.

Conclusions

This study has shown that, with a basic surgical set-up where ICCE is performed routinely and with reasonable quality, one can expect good postoperative vision outcomes in most eyes using a standard-power IOL. We found that 82.7% of eyes with an AC-IOL obtained visual acuity of 6/60 or better without additional correction 2 years after surgery. With additional correction after refraction we found that over 95% had vision of 6/60 or better and over 85% had "normal" vision (6/18 or better). These findings are comparable to those reported for ICCE-AG and for ECCE-PC IOL surgery in similar settings. Previous studies have documented the relative safety of ICCE with the new generation of AC-IOLs. Our study, which also included corneal endothelial cell data, gives further evidence that there is a rationale for using anterior chamber IOLs after primary ICCE surgery.

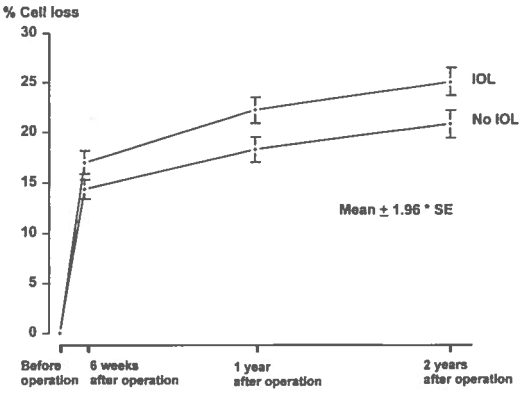


Figure 3. Postoperative corneal endothelial cell loss by treatment groups.

References

1. Thylefors B, Negrel AD, Pararajasegaram R, Dadzie KY. Global data on blindness. Bull World Health Organ 1995;73:115–21.
2. Thylefors B. A global initiative for the elimination of avoidable blindness [editorial]. Am J Ophthalmol 1998;125:90–3.
3. Kupfer C. The International Agency for the Prevention of Blindness [editorial]. Am J Ophthalmol 1994;117:253–7.
4. Limburg H, Kumar R, Bachani D. Monitoring and evaluating cataract intervention in India. Br J Ophthalmol 1996;80:951–5.
5. Murthy GVS, Gupta SK, Talwar D. Assessment of cataract surgery in rural India. Visual acuity outcome. Acta Ophthalmol Scand 1996;74:60–3.
6. Gupta AK, Tewari HK, Ellwein LB. Cataract surgery in India: results of a 1995 survey of ophthalmologists. Indian J Ophthalmol 1998;46:47–50.
7. Woods AC. The adjustment to aphakia [editorial]. Br J Ophthalmol 1963;55:1268–72.
8. Hogeweg M, Sapkota YD, Foster A. Acceptability of aphakic correction. Results from Karnali eye camps in Nepal. Acta Ophthalmol (Copenh) 1992;70:407–12.
9. Prajna NV, Rahamatullah R. Changing trends in the intraocular lens acceptance in rural Tamil Nadu. Indian J Ophthalmol 1995;43:177–9.

10. Apple DJ, Solomon KD, Tetz MR, et al. Posterior capsule opacification. Surv Ophthalmol 1992;37:73–116.
11. Gillies M, Brian G, La Nauze J, et al. Modern surgery for global cataract blindness: preliminary considerations. Arch Ophthalmol 1998;116:90–2.
12. Apple DJ, Brems RN, Park RB, et al. Anterior chamber lenses. Part I: Complications and pathology and a review of designs. J Cataract Refract Surg 1987;13:157–74.
13. Apple DJ, Hansen SO, Richards SC, et al. Anterior chamber lenses. Part II: A laboratory study. J Cataract Refract Surg 1987;13:175–89.
14. Lim ES, Apple DJ, Tsai JC, et al. An analysis of flexible anterior chamber lenses with special reference to the normalized rate of lens explantation. Ophthalmology 1991;98:243–6.
15. Auffarth GU, Wesendahl TA, Brown SJ, Apple DJ. Are there acceptable anterior chamber intraocular lenses for clinical use in the 1990s? An analysis of 4104 explanted anterior chamber intraocular lenses. Ophthalmology 1994;101:1913–22.
16. Hassan TS, Soong HK, Sugar A, Meyer RF. Implantation of Kelman-style, open-loop anterior chamber lenses during keratoplasty for aphakic and pseudophakic bullous keratopathy. A comparison with iris-sutured posterior chamber lenses. Ophthalmology 1991;98:875–80.
17. Koenig SB, McDermott ML, Hyndiuk RA. Penetrating keratoplasty and intraocular lens exchange for pseudophakic bullous keratopathy associated with a closed-loop anterior chamber intraocular lens. Am J Ophthalmol 1989;108:43–8.
18. Vogel M, Behrens-Baumann W, Petersen J, et al. Vergleich der Komplikationen nach intra- und extrakapsulärer Kataraktextraktionen mit Linsenimplantation: Ergebnisse einer prospektiven, randomisierten, klinischen Studie. Klin Monatsbl Augenheilkd 1993;203:43–52.
19. Mehra V, Minassian DC. A rapid method of grading cataract in epidemiological studies and eye surveys. Br J Ophthalmol 1988;72:801–3.
20. The South Asian Cataract Management Study. I. The first 662 cataract surgeries: a preliminary report. Br J Ophthalmol 1995;79:1029–35.
21. Snellingen T, Shrestha BR, Gharti MP, et al. Socioeconomic barriers to cataract surgery in Nepal: the South Asian Cataract Management Study. Br J Ophthalmol 1998;82:1424–8.
22. Vecchi M, Braccio L, Orsoni JG. The Topcon SP 1000 and Image-NET Systems: a comparison of four methods for evaluating corneal endothelial cell density. Cornea 1996;15:271–7.
23. Hennig A, Evans JR, Pradhan D, et al. A randomised controlled trial of anterior-chamber intraocular lenses. Lancet 1997;349:1129–33.
24. Powe NR, Schein OD, Gieser SC, et al. Synthesis of the literature on visual acuity and complications following cataract extraction with intraocular lens implantation. Arch Ophthalmol 1994;112:239–52.
25. Prajna NV, Chandrakanth KS, Kim R, et al. The Madurai Intraocular Lens Study. II: Clinical outcomes. Am J Ophthalmol 1998;125:14–25.
26. Natchiar G, Robin AL, Nalgirkar AR, Krishnadas R. Posterior capsule tears during extracapsular cataract surgery in India. Arch Ophthalmol 1993;111:706–8.
27. Cook NJ. Evaluation of high volume extracapsular cataract extraction with posterior chamber lens implantation in Sierra Leone, west Africa. Br J Ophthalmol 1996;80:698–701.
28. Egbert PR, Buchanan M. Results of extracapsular cataract surgery and intraocular lens implantation in Ghana. Arch Ophthalmol 1991;109:1764–8.
29. Al Faran MF. Visual outcome and complications after cataract extraction in Saudi Arabia. Br J Ophthalmol 1990; 74:141–3.
30. Bates AK, Cheng H, Hiorns RW. Pseudophakic bullous keratopathy: relationship with endothelial cell density and use of a predictive cell loss model. A preliminary report. Curr Eye Res 1986;5:363–6.
31. Bates AK, Cheng H. Bullous keratopathy: a study of endothelial cell morphology in patients undergoing cataract surgery. Br J Ophthalmol 1988;72:409–12.
32. Bates AK, Hiorns RW, Cheng H. Modelling of changes in the corneal endothelium after cataract surgery and penetrating keratoplasty. Br J Ophthalmol 1992;76:32–5.
33. Long-term corneal endothelial cell loss after cataract surgery. Results of a randomized controlled trial. (Oxford Cataract Treatment and Evaluation Team) Arch Ophthalmol 1986;104: 1170–5.
34. Fletcher A, Vijaykumar V, Selvaraj S, et al. The Madurai intraocular lens study. III: Visual functioning and quality of life outcomes. Am J Ophthalmol 1998;125:26–35.
35. Lewallen S, LeMeausurier RT. Extracapsular cataract extraction in developing countries [letter]. Arch Ophthalmol 1993; 111:18.

Appendix

THE SOUTH ASIAN CATARACT MANAGEMENT STUDY

A REGIONAL COLLABORATIVE PROGRAMME

Protocol

THE L.V. PRASAD EYE INSTITUTE
HYDERABAD, INDIA

INSTITUTE OF MEDECINE, TRIBHUVAN UNIVERSITY
KATHMANDU TEACHING HOSPITAL, NEPAL

INSTITUTE OF COMMUNITY OPHTHALMOLOGY
UNIVERSITY OF CHITTAGONG, BANGLADESH

in collaboration with

INTERNATIONAL CENTRE FOR EYE HEALTH (ICEH)
UNIVERSITY OF LONDON, UK

OXFORD CATARACT TREATMENT AND EVALUATION TEAM (OCTET)
OXFORD EYE HOSPITAL & UNIVERSITY OF OXFORD,UK

Coordinator
Institute of Community Medicine
University of Tromsø, Norway

SACMS Regional Office
G.P.O. Box 5950, Kathmadu Teaching, Hospital, Kathmandu, Nepal

THE SOUTH ASIAN CATARACT MANAGEMENT STUDY

A REGIONAL COLLABORATIVE PROGRAMME

THE L.V. PRASAD EYE INSTITUTE
HYDERABAD, INDIA

INSTITUTE OF MEDECINE, TRIBHUVAN UNIVERSITY
KATHMANDU TEACHING HOSPITAL, NEPAL

INSTITUTE OF COMMUNITY OPHTHALMOLOGY
UNIVERSITY OF CHITTAGONG, BANGLADESH

in collaboration with

INTERNATIONAL CENTRE FOR EYE HEALTH (ICEH)
UNIVERSITY OF LONDON, UK

OXFORD CATARACT TREATMENT AND EVALUATION TEAM (OCTET)
OXFORD EYE HOSPITAL & UNIVERSITY OF OXFORD,UK

Coordinator
Institute of Community Medicine
University of Tromsø, Norway

SACMS Regional Office
G.P.O. Box 5950, Kathmadu Teaching, Hospital, Kathmandu, Nepal

TABLE OF CONTENTS

1. BACKGROUND:

Rapid and remarkable development of intraocular lens technology the last decade has made intraocular lens (IOL) implantation the standard approach to visual rehabilitation after cataract extraction in wealthy industrialized nations.

The restoration of near normal physiological vision with a successful IOL implant has been the single most important surgical technological achievement in ophthalmology this century and may be the greatest development since the introduction of modern cataract surgery by Daviel.

The visual distortion caused by traditional aphakic spectacle correction (25-35% image magnification, aniseikonia, spherical aberration and ring scotoma) is today, with the wide indications for lens implant, virtually part of ophthalmic surgical history in high income economies. For developing countries, however, the introduction of implant technology poses a major socioeconomic and surgical dilemma (24,25,27,31).

In developing countries, public spending in all sectors grew rapidly in the 1960s and 1970s. In the 1980s slow economic growth and recorded budget deficits have, however, forced reductions in public spending; in many developing countries health spending has in fact declined on a per capita basis (fig 1. and 2). Public and private spending together is on average less than 5% of that spent in developed countries (28); even if this was spent as cost effectively as possible , it would probably be insufficient to meet critical health needs.

But in most low income countries the general budget stringency makes it difficult to argue for more public spending. For the foreseeable future, government efforts o to improve health is unlikely to rely on increase in public spending financed by debt or tax revenues or on the reallocation of public expenditures from other sectors, even though such increases or reallocations would be economically as well as socially justified.

Funding of development programmes in eye care must also be seen in view of the economic realities above. Eye Care Programmes are in large funded through private initiatives in most developing countries with a large dependence on external donors. Government hospitals often lack both capital and human resources needed to upgrade surgical capabilities. Over 90% of the worlds cataract blind live in the rural areas of poor and intermediate income countries that in general have insufficient resources to develop implant surgical technology as is practised in higher income countries.

The World Health Organization estimated the total number of blind worldwide to some 27-35 million people blind using the WHO definition finger counting less than 3 meter (<3/60)-1987 update (29) -some 50-60% of these are suffering from blinding cataract .

In Asia alone some 11 million (65% of the global cataract blind) are blind of this condition with the overwhelming majority residing in the rural villages of the least developed countries of South Asia (Sri Lanka, India, Nepal, Bhutan, Bangladesh, Myanmar -formerly Burma). In India alone some 8-10 million are estimated cataract blind and a turnover of some 1.3-1.4 million cataract operations are done annually-most in the rural setting with temporary mobile facilities ("eye camps").

The vast majority of the total surgical turnover is done with traditional low-cost operating technique of intracapsular lens extraction (ICCE) with postoperative aphakic spectacle correction as the only means of visual restoration. Previous studies in Nepal (7) and recent studies in central India (26) and Bangladesh (unpublished data) have shown that aphakic spectacle correction as practised in these settings is often inadequate for a complete visual restoration of (6/18) or better.

The National Blindness Survey in Nepal (1981) identified 146 aphakic eyes in a total sample of 39,000 individuals screened. 50% of these were identified blind on presentation to the examiner. Some 65% of these were simply not wearing spectacles. Either aphakic spectacles are not available at the time of operation or at follow-up or the standard spectacles donated are misplaced or broken. Often even when the standard spectacles are available patients are not using them.
During the late autumn 1989 a series of informal discussions were held at the International Centre for Eye Health (ICEH), University of London, between Asian colleagues, ICEH staff, course members and the Programme manager of WHO/PBL Geneva, addressing the issue of intraocular lens implants (IOL) as alternative to aphakic spectacle correction in the context of developing countries.
Based on these discussions an international workshop was co-hosted by the Institutes of Clinical and Community Medicine, University of Tromsø the 23-25 May 1990 (see report). The aim of the workshop was to review laboratory and clinical data on intraocular lens technology as a basis for the formulation of guidelines for operations research strategies with IOLs appropriate to developing regions as alternatives to traditional management of aphakia (spectacle correction).

Based on the latest available laboratory data on anterior chamber intraocular lens implants (AC-IOLs) (yet unpublished) from the Center for Intraocular Lens Research and on conclusions from the plenary discussions came a clear consensus that there was an urgent need, as first priority, to initiate a multicentre randomized clinical trial with the modern generation anterior chamber intraocular lenses using traditional ICCE. General guidelines were agreed upon for the conduct of such a trial (see report).

2.0 THE NEED FOR PROSPECTIVE CLINICAL TRIALS

In the some 40 years of development of IOLs only a handful of prospective clinical studies have been conducted with a follow up of any length (8-10,14-15,18,21). Many of these studies, however, lacked a randomization procedure and had extremely high losses of follow up. Even the most recent studies published used IOLs that today are largely outdated (20,22).

In relation to AC IOLs, to our knowledge there is no study that has followed patients with the modern generation of Kelman - Choyce Variation IOLs over any length. No controlled clinical intervention trial has included a sample large enough such that the probability (power) of detecting significant differences of cases of poor outcome (v.a < 0.3) was acceptable (power:beta <.10 at alpha=.05 level of significance). No scientifically controlled clinical trial with IOLs has to date been conducted in South Asia.

3.0 OBJECTIVES OF TRIAL

The study of the outcome after 3 years (with the possibility of extension) of eyes with ICCE implanted with AC-IOLs compared with ICCE (non implant) and aphakic spectacle correction in different centres of South Asia.

4.0 STUDY DESIGN

A multicentre randomized controlled study design with randomization to each participating centre. Sample size based on calculations set out in the guidelines of Tromsø meeting, May 1990 (ref. point 7.3 Workshop Report). A minimum of 2000 cases included over one year with follow up of a minimum of 2 years.

5.0 CHOICE OF IOL:

5.1 The Review of AC-IOLs:

The first generation of anterior chamber lenses were introduced soon after Harold Ridley's first intraocular implant of a disc shaped posterior chamber lens in November of 1949.

The first generation AC IOLs:(1952-1962)
The problems encountered with the posterior chamber lens including the difficulty of ECCE technique and lens insertion and frequency of dislocation-surgeons soon considered the placement of IOLs in the anterior chamber. This marked the development of the first generation of AC IOLs from 1952 to 1962. It soon became apparent that some of the AC lenses gave a high frequency of corneal complications mainly because of poor design e.g. steep anterior curve and short radius of curvature leading to endothelial trauma. Some of these early generation stiff AC lenses did however quite well when properly designed, polished and accurately sized. The Choyce Mark I lens was well tolerated for more than 20 years (11,12).

The second generation AC IOLs : (1962...)
The continuous development of the AC IOLs brought forth new designs of AC IOLs. Some of these when properly sized provide excellent long-term results. Other poorly designed and polished AC-IOL were implanted in the thousands during the late 70s and early 80s gave AC-IOL in general a bad name (2,3).

The constellation of symptoms now termed the UGH syndrome (Uveitis-Glaucoma-Hyphema) were attributed to the numerous implantation of poorly polished and designed closed loop lenses and unlicensed copies of the Choyce Mark IX lenses. These lenses led to the dramatic increase of Pseudophakic Bullous Keratopathy (PBK). Lenses that were well polished and designed continued to give favourable results (1,13).

A parallel development was the introduction of iris plane lenses used quite extensively in the latter half of the 1970s and beginning of the last decade. In general these lenses proved to give unacceptable complication rates (5) and were soon taken off the U.S. market. The introduction of the microsurgical techniques of extracapsular extraction (ECCE) and modern posterior chamber lenses paralleled to an observed increasing frequency of PBK of eyes implanted with poor quality lenses has led, in some circles, to the general condemnation of all AC IOLs and introduced a bias to the recent debate of a potential role of the modern generation of AC IOLs (4).

5.2 Update on the Latest Clinico-Pathological Data.
The newest data on AC-IOLs from the Center for Intraocular Lens Research, Storm Eye Institute, Medical University of South Carolina concludes:*
"An unacceptable complication rate is associated with the closed-loop design when compared to either the quadripod or tripod open loop lens styles. Furthermore, the closed-loop designs, while comprising an estimated 45% of the total number of AC-IOLs estimated to be implanted in the United States (n=647,000) were responsible for 80% of the AC-IOLs explanted after complications. It is also important to note that the incidence of removal of closed loop lenses increases over time, thus indicating a smouldering chronic process that slowly worsens.
In contrast, most open-loop lenses that have been removed (relatively few actually require removal) are explanted within the first year or two (fig 3 and 4). Because few lenses are seen to be explanted in later years (from three to ten years) , it shows that once they are in place in the absence of complicated surgery, they indeed do very well.
Based on these observations it is proposed the use of relatively safe Kelman-Choyce modifications of flexible one piece all PMMA AC-IOLs."

6.0 ORGANIZATIONAL AND ADMINISTRATIVE STRUCTURE

6.1 Study Title
THE SOUTH ASIAN CATARACT MANAGEMENT STUDY

6.2 Committees

Steering Committee:

Dr. M.P. Upadhyay, Institute of Medicine, Kathmandu Teaching Hospital,Tribhuvan University.
Dr. R.P. Pokhrel, Nepal Eye Hospital, Kathmandu.
Dr. R. Husain,Institute of Community Ophthalmology,Chittagong.
Prof. S. M. Ali, Institute of Postgraduate Medicine and Research, Dhaka.
Mr. H.Cheng, Oxford Cataract treatment and Evaluation team (OCTET), Oxford Eye Hospital, University of Oxford.
Dr. T. Snellingen, Institute of Community Medicine,University. of Tromsø

The steering committee will meet annually. It will be responsible for the safe conduct of the trial including the monitoring and evaluation through an independent review committee.

*Presented to the Advisory Board on The Prevention of Blindness, World Health Organization, Geneva, 3-7 December 1990 by D.J.Apple. Based on a survey 1,204 closed-loop anterior chamber intraocular lenses (AC-IOLs) and 310 open-loop AC-IOLs assessioned between November 1982 and January 1990 and an analysis of complication rates after normalization of data with respect to market share totals (30).

Review Committee:

Mr.Hung Cheng, Oxford Cataract Treatment and Evaluation Team (OCTET), Oxford Eye Hospital, University of Oxford.

External members:
1.Professor Egil Arnesen, Section for Epidemiology and Biostatistics, Institute of Community Medicine, University of Tromsø.
2.Clinical member to be designated by independant body.

The review committee will review the incoming data at regular inrevals.

Study Group

Each participating centre will be represented by a Study- Coordinator in the projects study group. This group will meet at regular intervals with the programme coordinator and will jointly be responsible for the academic inputs and outputs of the project.

Projects Advisor

Professor David J. Apple, Storm Eye Institute, Medical University of South Carolina.

6.3 Ethical Committee
The ethical committee of the University of Tromsø and the appropriate committee for each participating centre will review and approve the protocol.

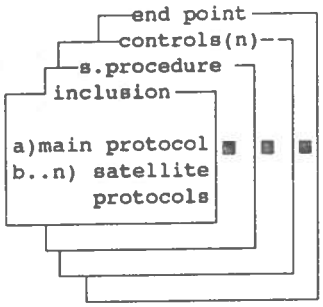
6.4 Programme Coordinator
The programme coordinator will be responsible for the overall coordination of the trial: The coordination of the participating centres locally; the collaborative research expertise and the participating centres; industry and funding bodies.

6.5 Administrative Officer and Data Systems Coordinator
The daily administration of the project will be secured through a full time employed administrator who will be responsible for all administrative affairs including coordination of procurement of all capital and usable goods including data hardware and software and its installation; the teaching of local technical staff; data monitoring and maintenance and coordination of a central data monitoring centre.

6.6 Principal Investigator (annexure 1)
The principal investigator of each participating centre will be responsible for the overall administration and smooth running of the project,the liaison between the participating centre, relevant government ministries, monitoring centre and Tromsø University.

6.7 P.C. Study Coordinator (annexure 1)
The study coordinator will be the overall responsible for the daily monitoring and coordination of the project at each p.c.

6.8 Data Monitoring Centre and Data Processing:
The daily coordination and monitoring will be run by the study coordinator and programme administrator through a local coordinating administrative centre located at the Kathmandu Teaching Hospital, Tribhuvan University, Kathmandu. This centre will in close collaboration with the steering committee be responsible for the collation, monitoring and summarical analysis of all data from the participating centres.
To guarantee maximum standardization and control of the generated data a customized relational database software package will be developed.



6.9 Institutional and Field Organization:

The institutional and field infrastructure will be standardized in relation to procedure for examination and data collection.
Logistical support will vary however according to each centres needs and will be described in manual of operations.
Basically a minimum of three teams with a programme coordinator will be essential for the smooth conduct of the trial.

Full time employed staff:
1. Clinical Evaluation Team

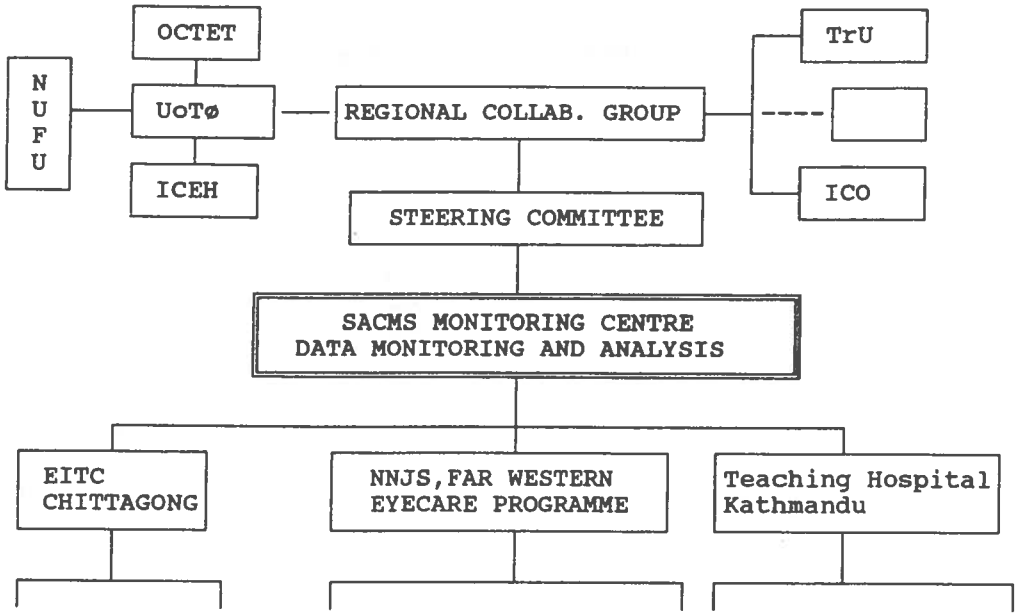
This team will be responsible for the ongoing clinical evaluation.
- 2 (Two) Ophthalmic Medical Officer/Ophthalmic Assistant.
- 1 (One) Secretary/Enumerator

Each team will have one standardized evaluation unit.
2. Surgical Teams (2)
- 1 (One) Ophthalmic Surgeon
- 1 (One) Junior Doctor
- 1 (One) Ophthalmic nurse/paramedic

3. Mobile Field Team:
- 1 (One) Driver
- 1 (One) Ophthalmic Assistant

Field Workers:
Infrastructure support in the field will be secured by field workers either through the existing primary health or eye care structure or newly recruited workers from the inclusion area.

6.10 Layout of Proposed Organizational Structure:



subcentres and mobile field evaluation teams

EITC = Eye Infirmary and Training Complex Chittagong

ICEH = International Centre for Eye Health

OCTET = Oxford Cataract Treatment and Evaluation Team

NUFU = Norwegian National Committee for Development Research and Education.

TrU = Tribhuvan University

UoTø = University of Tromsø

6.11 Publication and Presentation of Papers Scientific Societies;Ownership of Data:

Papers published will appear as multi author papers under heading South Asian Cataract Management Study.The principal paper detailing the overall results will appear with the study coordinator and principal investigators from participating centres as first authors. Other papers pertaining to the trial may appear with that participant as first author who has put most effort into realizing the completion of the project.
The agreements outlined will also pertain to the formal presentation of papers in scientific societies.
The data generated from each participating centres will be the property of the participating centres and the Operations Unit of the SHSR/ISM, University of Tromsø. Any centre that has been the main contributor to generation of data for a particular area of the study will have property rights to the data generated from that particular input.

7. PRINCIPAL OUTCOME OF INTEREST AND SAMPLE SIZE CONSIDERATIONS

Vision with Best Possible Correction (BPC) at End Point
a) Visual Acuity < 6/18 (0.3) b.c.v.= "Poor Outcome":
b) Visual Acuity 6/18 (0.3) or better b.c.v. = "Good Outcome"

The principal outcome of interest for sample size calculation agreed in consensus at the Tromsø meeting (point 7.3 1b):

Poor outcome defined as VISION with BEST POSSIBLE CORRECTION (BPC) less than 6/18 (0.3).

With expected minimum proportion of principal outcome of p1 = 0.05 and p2 = 0.10 ; study power 0.95 (type II error .05) type I error .05 (alpha) -gives a sample size estimate for a two-tailed test of 750 cases per group. Absolute minimum number followed to end point equal 1500 cases (16,17,19).**
The probability of dying under a five year follow up is .20 for a 64 year rural Bangladeshi female (6). A minimum of 2500 cases included is recommended. Maximum 500 cases are expected deceased before end point.

**The expected minimum proportions chosen for the principal (poor) outcome are based on the only data available to date from the South Asian setting on long term outcome of ICCE surgery. A longitudinal follow up study of 547 patients undergone ICCE with evaluation of outcome after one year was undertaken in Raipur (central India). 92% of patients had v.a. 6/18 or better with no significant difference between hospital or eyecamp setting (26).

8.0 OTHER OUTCOME VARIABLES OF INTEREST : CORE INFORMATION

8.1 Visual Acuity with Patient Available Correction (BAC) at Presentation and End Point.

a) Visual Acuity < 6/18 (0.3) = "Poor Available Outcome"
b) Visual Acuity 6/18 (0.3) or better = "Good Available Outcome"

8.2 Intra Ocular Pressure (IOP) with Applanation Tonometri.

Preoperative
Follow Up(n)

Glaucoma Suspect
a) Rise in Intraocular Pressure:
Postoperative Pressure Increase 10 mmHg above preoperative (baseline) measurement:

b)Postoperative pressure of 25-30 mmHg.

Secondary Glaucoma
IOP > 30 mmHg.

8.3 Ocular Examination (See Guide to Clinincal Examination)

Conjunctiva and Wound
Cornea
Anterior Chamber
Implant
Iris and Pupil
Vitreous
Red Reflex
Fundus

9.0 SURGICAL VARIABLES OF INTEREST:

9.1 Procedure:
anaesthesia
pressure reduction
section
method of lens extraction
iridectomies

9.2 Surgical Complications
intervention aborted
implantation aborted
vitreous loss
dislocation of implant
iridodialysis
hyphema
choroidal haemorrhage

10.0 POSTOPERATIVE COMPLICATIONS:
gaping wound
acute corneal decompensation
flat chamber
iritis/hypopyon/intraocular infection
hyphema
prolapsed iris
prolapsed vitreous to wound
retinal detachment
secondary surgical intervention and explantation
severe pressure rise > 36mmHg
other (stated)

11. QUALITY CONTROL:Reliability and validity of core variables

11.1 Monitoring of Study Data
The quality of data will be assesed by the monitoring centre on visits to each centre at regular intervals (first 100 inclusions then every 200 inclusions). The clinical member of the review committee will visit each centre at the interim period and on the completion of the final evaluation.

11.2 Photodocumentation
The quality of data will be assesed with the help of standardized photodocumentation using digitial image capture,retrieval using mass storage system (Imagenett Ophthalmic Diagnostic System).
This assesement will include the preoperative and the three postoperative evaluations (6 weeks, 12 months,24 months).

12. INCLUSION CRITERIA

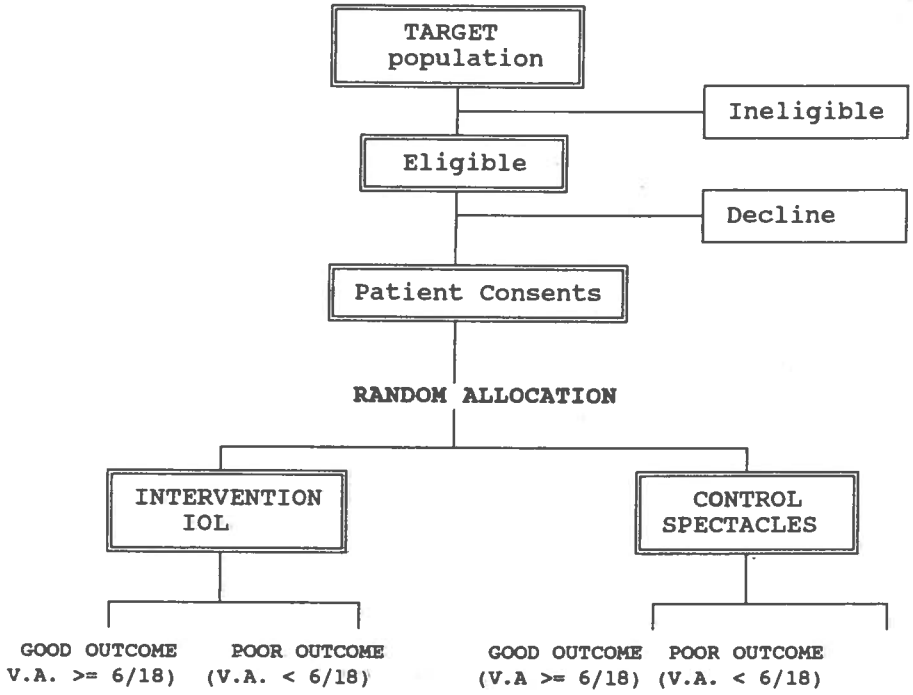
Eligibility
Male and females between 40 and 75 years with best corrected visual acuity less than 6/60 (0.1) - PL inclusion eye, 6/36 - PL controlateral eye due to senile cataract grade 2B, 3-5 (Cataract Grading System, Minassian et al. (23)).

13. EXCLUSION CRITERIA
1. Diagnosed glaucoma or IOP > 26 mmHg.
2. Acute or chronic corneal disease including Fuchs's Dystropy or other severe endothelial disease.
3. History or evidence of acute or chronic ocular inflammatory disease.
4. Shallow anterior chamber with iridocorneal contact.
   Evidence of chronic iris disease and or defect.
5. Evidence of anterior and or posterior synechia.
6. Evidence of traumatic or complicated cataract.
7. Cataract Grade 0-2a, 4 and 5.
8. No Perception of Light and or No Projection of Light in 3 of out of 4 quadrants.
9. Suspected non lenticular axial high myopia.
10. Diagnosed Juvenile (Type I) Diabetes Retinopathy or Adult Onset (Type II) Diabetes with severe Background or Proliferative Retinopathy in either Eye.
11. One eyed and or aphakic patients.
12. Psychiatric patients and mentally retarded.
13. Chronic or Severe Systemic Disease likely to cause death within 3 years.

14. RANDOMIZATION

Randomization will be done at each participating centre using randomization lists and system of sealed envelopes.
The randomization shall be openes at completion of the extraction of the crystaline lens.

Once the patient has been allocated to a study group he/she cannot be excluded from the study and is locked in the allocated group regardless of the outcome of the surgical procedure or follow up events:ex:Implantation aborted or explanted during procedure;Abortion of Surgical Procedure;Explantation of Implant: Post.op or after long term follow up.



15. ETHICAL CONSIDERATIONS:

15.1 Informed Consent

Informed consent will be solicited from each patient and with the inclusion of the following points:

1. On entering the study he/she will have a 50% chance of receiving an IOL instead of standard thick glasses free of cost.

2. On enrolment a meticulous routine of follow up is expected by patient. All expenses will be covered including preoperative examination, surgical procedure, spectacles and IOL, postoperative follow up.

3. Once included in the trial the importance of participation in the follow up routines will be underlined.

4. If the patient declines to be included in the trial he/she will receive the best available surgical treatment as practised routinely at the participating centre.

15.2 Early Termination of Trial:
Any decision of early termination of trial will be taken by an extraordinary meeting of the steering committee in accordance with findings of the review committee based on the difference in the two groups of following defined criteria:
1.Loss of Eye (Irreversible blindness)
2.Endophthalmitis
3.Vitreous Loss
4.Corneal Decompensation
5.Secondary and Pupil Block Glaucoma
6.Visual Acuity < 3/60 (b.c.v.)

15.3 Prolongation of Follow Up:
The follow up period may be prolonged if the two groups are equal in visual outcome but the quantitative and qualitative difference of the corneal endothelium between the two groups is deemed clinically significant.

15.4 How to Deal With Second Eye:
It is expected that some patients will solicit an operation on the controlateral eye before the end point of the trial.

The folllowing guidelines will therefore be recommended.
Aphakic Patients:
a)No decision for surgery of second eye should be taken in the first 18 months if the visual acuity on the study eye is 6/12 or better.

b)All patients with a visual acuity 6/12 or better will be urged to postpone any surgery on second eye.

The second eye will not be randomized in the study but will be scrutinized under the same observations and management.

IOL cases:
All patients who received a IOL in study eye will recieve AC IOL Implant on other eye when there is a medical indication for proceeding with operation on second eye (mature cataract, phacolytic glaucoma etc.).

16. CRITERIA FOR PARTICIPATION:

16.1 Clinical Centres
1. University Eye Centre or Provincial Eye Unit preferably with prior or ongoing research experience.
2. Cataract surgical turnover of minimum 1000 intracapsular cataract extractions per year of a stable non migrant population of patients.
3. Logistical capabilities are deemed such that long term follow up is possible.
4. A stable continuous staffing of an ophthalmic surgeon fitting the criteria of inclusion for surgeons (15.3) preferably with a staffing of 2 ophthalmic surgeons.
5. Established local medical council and or ethical committee.

16.2 Principal Investigator:
Ophthalmic surgeon with working knowledge of English preferably with some research experience.

16.3 Participating surgeons:
Ophthalmic surgeon minimum (DO) with minimum 2 years surgical experience with a minimum of 200 cataract extractions. All participating centres will when included sign a statement of agreement to adhere strictly to the protocol. Based on findings of the review committee the steering committee can exclude a centre from the trial if it breaches agreements that results in lack of meaningful data or data show an ethically unacceptable difference between groups in visual acuities and or poor outcome events.

17.SATELLITE PROTOCOLS

17..1 Corneal Status (whole or sub-sample)
Depending on logistical capabilities -to determine the rate of endothelial loss over time, corneal endothelium photography will be done on all cases using the endothelial cell software of the Ophthalmic Imaging System (IMAGEnet) at preop. and each evaluation schedule.

17.2 Cost/Effectivenes & Benefit Analysis
It is debated that introduction of IOL will increase the burden of the clinical centre in respect of running costs and increased demand for manpower. An activity and cost time analysis will focus on this issue.Appropriate research tools for the use in the assesement of cost/benefit will be defined.

18. ANTICIPATED TIME SCHEDULE:

1. Approval of Protocol by Ethical Committee of UoTr: June 1992.
2. Review and Approval of Protocol by local ethical committees and or medical research councils: July 1992
3. Establish Administrative Headquarters: August 1992.
4. Pilot Investigations/Training/Standardization: September- December 1992.
5. Inclusion: January- December 1993.
6. First Evaluation: 6 weeks post op.: Publication:1994
7. Interim Analysis Year 1 -Publication:1995
8. End Point Evaluation: Year 3:
9. Final data Analysis and Publication: 1996

19. FUNDING

The United Nations Section of the Royal Norwegian Ministry of Foreign Affairs and the Norwegian National Committe for Development Related Research under the National Research Council for the Sciences and Humanities (NAU/NAVF) have funded expenses for preliminary programme planning and preparation.

A 4 year programme budget of total NOK 4 780 000,- has been granted by the Norwegian National University Council for Development Research and Education (NUFU).

REFERENCES

1. Absolon MJ. Long Term Follow Up of primary Il Mark IX anterior chamber implantation. Am intra-Ocular Implant Soc J 1985; 11:162-164.

2. Apple DJ, Brems RN, Park RB, Norman DK, Hansen SO, Tetz MR, Richards SC, Letchinger SD. Anterior chamber lenses. Part I: Complications and pathology and a review of designs. J Cataract Refract Surg 1987; 13:157-174.

3. Apple DJ, Hansen SO, Richards SC, Ellis GW, Kavka-Van-Norman D, Tetz MR, Pfeffer BR, Park RB, Crandall AS, Olson RJ. Anterior chamber lenses. Part II:A laborotary study. J Cataract Refract Surg 1987; 13:175-189.

4. Apple DJ, Kelman CD, Kraff MC, Stark WJ. FDA Ophthalmic Device Hearing. 1986.

5. Apple DJ, Mamalis N, Olson RJ, Kincaid MC. INTRAOCULAR LENSES Evolution, Designs,Complications and Pathology. Baltimore: Williams and Wilkins, 1989:11-41,45-57.

6. Bangladesh Bureau of Statistics. Statitical Pocketbook of Bangladesh. Dhaka: Bangladesh Bureau of Statistics, 1987:59-61.

7. Brilliant GE. The Epidemiology of Blindness in Nepal, report of the 1981 Nepal Blindness Survey. Chelsea,Michigan: Seva Foundation, 1988:216-217.

8. Cheng H. Current Status of Cataract Surgery-A Review of Personal Experience. Eye 1987; 1:551-556.

9. Cheng H, McPherson K, Bron AJ. I. Cataract Surgery:interim results and complications of a randomized controlled trial. Br J Ophthalmol 1986; 70:402-410.

10. Cheng H, McPherson K, Bron AJ. II. Use of a grading system in the evaluation of complications in a randomized controlled trial on cataract surgery OXFORD CATARACT TREATMENT AND EVALUATION TEAM (OCTET). Br J Ophthalmol 1986; 70:411-414.

11. Choyce PD. The Mark VI,Mark VII and Mark VIII Il anterior chamber implants. Proc R Soc Med 1965; 58:729-731.

12. Choyce PD. Long-term tolerance of Il Mk I and Mk VIII anterior chamber implants. Proc R Soc Med 1970; 63:310-313.

13. Choyce PD. The VIth Binkhorst Medal Lecture Anterior Chamber Implants - Past, Present,Future. Am intra-Ocular Implant Soc J 1982; 8:42-51.

14. Eriksen JS. A Long-Term Follow Up of Cataract Extraction With and Without Intraocular Lens Implantation. Acta Ophthalmol Copenh 1983; 61:576-582.

15.Eriksen JS, Nielsen NV. Visual Outcome and Complications in 287 Intraocular Lens Implants (Federow) Compared With 290 Intracapsular Cataract Extractions. Acta Ophthalmol Copenh 1981; 61:67-75.

16. Fleiss JL. Statistical Methods for Rates and Proportions. New York: John Wiley and Sons, 1981:260-279.

17. Javitt CJ. When Does the Failure to Find a Difference Mean That There is None. Arch Ophthalmol 1989; 107:1034-1040.

18. Kraff C, Sanders DR, Lieberman HL. Monitoring for Continuing Endothelial Cell Loss With Cataract Extraction and Intraocular Lens Implantation. ophthalm 1982; 89:30-34.

19. Lachin JM. Introduction to Sample Size determination and Power Analysis for Clinical Trials. Controlled Clinical Trials 1981; 2:93-113.

20. Liesegang TJ, Bourne WM, Ilstrup DM. Prospective 5-Year Postoperative Study of Cataract Extraction and Lens Implantation. Tr Am Ophth Soc 1989; LXXXVII:57-78.

21. Liesegang TJ, Bourne WM, Ilstrup MS, Duane M. Short and Long-Term Endothelial Cell Loss Associated With Cataract Extraction and Intraocular Lens Implantation. American Journal of Ophthalmology 1984;97:32-39.

22. Matsuda M, Myiake K, Masamura I. Long Term Endothelial Changes After Intraocular Lens Implantation. Am J Ophth 1988; 105:248-252.

23. Mehra V, Minassian DJ. A rapid method of grading cataract in epidemiological studies and eye surveys. Br J Ophthalmol 1988; 72:801-803.

24. Pizzarello L. Intraocular Lens Use in Developing Countries. Ophth Surg 1989; 20:240-240.

25. Pizzarello L, Ellwin LB. The choice of cataract surgical techniques in developing nations:Operations research considerations. Int Ophth 1990; 14:147-154.

26. Reidy A, Mehra V., Minassian D, Mahashabde S, Outcome of cataract surgery in Central India:a longitudinal follow-up study, Br J Ophthalmol 1991;75,102-105.

27. Taylor HR, Sommer A. Cataract Surgery: A Global Perspective. Arch Ophthalmol 1990; 108:797-798.

28. World Bank Washington DC. Financing Health Services in Developing Countries, A World Bank Policy Study. Washington D.C.: World Bank,1987:10-23.

29. World Health Organization. Available Data on Blindness (1987 Update). PBL 87/14.

30. WHO/PBL/91.1. Report of the Consultation on the Use of Intraocular Lenses in Cataract Surgery in developing Countries, Geneva 3-7 December,1990.

31. Young PW, Schwab L. Intraocular Lens Implantation in Developing Countries: An Ophthalmic Surgical Dilemma. Ophth Surg 1989; 20:241-244.

ANNEXURE 1:

LIST OF PARTICIPATING INVESTIGATORS,STUDY COORDINATORS AND REVIEW COMMITTEE:

A. Institute of Medicine, Kathmandu Teaching Hospital, Nepal.

Principal Investigator:	Dr. Shasank Koirala
Study Coordinator:	Dr. Jeevan Shresta

C. Institute of Community Ophthalmology, Chittagong University, Bangladesh.

Principal Investigator:	Dr. Rabiul Husain
Study Coordinator:	Dr. Fazlul Haque

REVIEW COMMITTEE:

Chairman: Mr. Hung Cheng FRCS FCOphth, Oxford Eye Hospital, University of Oxford, UK.

Prof. Egil Arnesen, Section for Epidemiology and Biostatistics, Institute of Community Medicine, University of Tromsø.

Prof. Erling Grønvold Olsen, Dept. of Ophthalmology, University Hospital, Tromsø.

Prof. Martin Vogel Augenklinik der Universitat Gottingen
(Appointed by Dr. D.J. Apple Centre for Intraocular Lens Research, WHO Collaborating Centre for Prevetion of Blindness).

ANNEXURE 2:

PARTICIPATING CENTRES

1. Institute of Medicine, Teaching Hospital, Tribhuvan University.

Far Western Eyecare Programme, Geta & Rapti Eye Hospital, Far Western development Zones.
Nepal National Prevention and Control of Blindness Programme & Norwegian Church Aid (NNJS\NCA).

This programme serves Seti and Mahakali and Rapti the three far western development zones of Nepal (population 2.1 million), Kiri District and other areas of the Indian border state of Uttar Pradesh.

It comprises two clinical centres (Dang and Geta) and mobile units that conduct seasonal eyecamps. The programme is run under the Nepal Prevention and Control of Blindness Programme in partnership with the NCA and NNJS with substantial funding support from the NORAD.

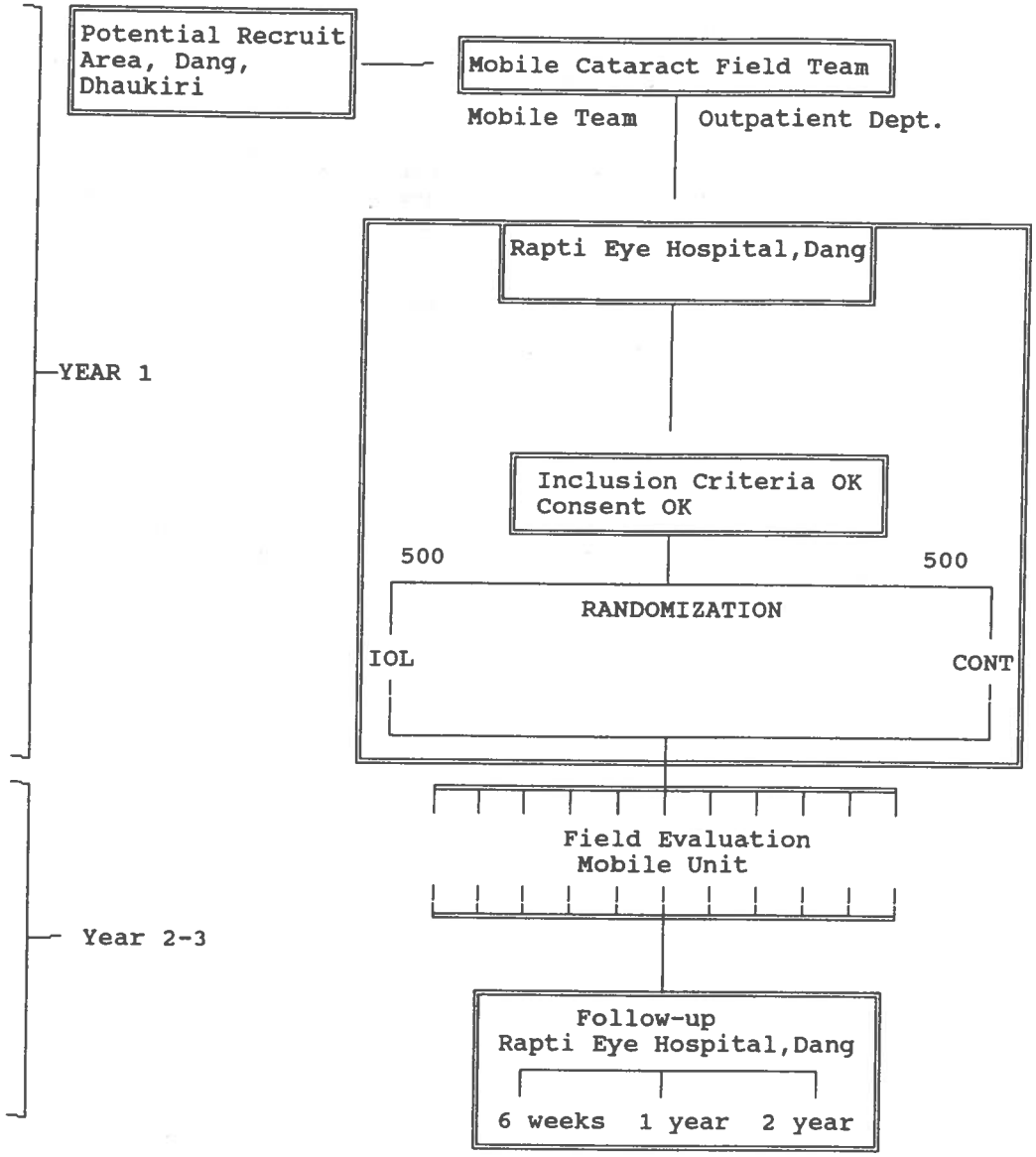
Rapti Eye Hospital:

Rapti Eye Hospital is located in the Dang Valley in the upper western part of the Terai belt which is situated on the foothills of the lower himalayan range and is part of the northern Ganges plain. After a development and construction phase of some 6 years the Rapti Eye Hospital is now a fully operational facility.

Logistical Considerations:

The Dang and Dhaukuri Valleys will be included in the encatchment area. Infrastructural support will be secured through field workers recruited through a local grass roots Organization (BASE).

FLOW CHART: DANG



2. The Institute of Community Ophthalmology (ICO), BNSB Eye Infirmary and Training Complex, Chittagong (CEITC).

Since its conception some 12 years ago the BNSB Eye Infirmary and Training Complex (EITC) functions today as a regional training centre for eye health care. Trainees have come from, Nepal, Buthan, Thailand and other countries in the region. The EITC is the national training centre for the BNSB base eye hospitals.

The complex serves the south eastern region of Bangladesh including Chittagong and surrounding area, Cox's Bazar region, Chattagram and the vast area of Chittagong Hill tracts. Several primary eye care centres are now being established in the surrounding districts.

The newly established Institute under the University of Chittagong is the first Post Graduate Institution on Community Ophthalmology in the South Asian region. It will serve as a regional post-gradual academic training centre for prevention of blindness.

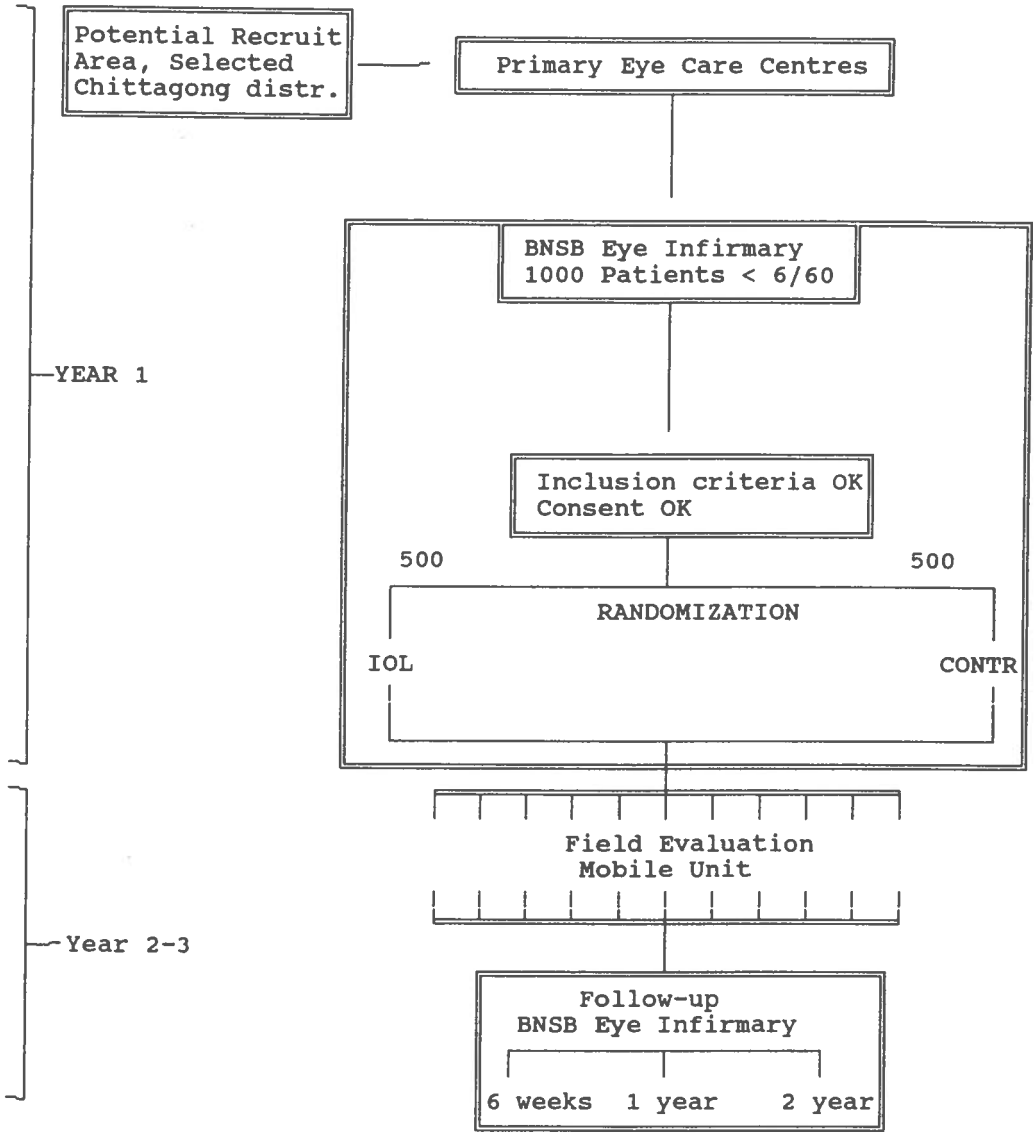
Logistical Considerations:

Regional Training Centre:

The EITC has a strong administrative and organizational structure and has several ongoing research programmes. For this programme a cataract treatment and evaluation unit will be organized and will serve as the regional training unit for the cataract management study.

The Primary Eye Care Centres of the inclusion subdistricts (Upazillas)will be the outreach centres for follow up.

FLOW CHART CHITTAGONG



Annexure 3

CONSENT TO OPERATION FORMULA

ID_____ Date____/____/____ Place_____

Name_____ Age_____ Sex_____(M,F)

1. After having recived information on the nature and purpose of the operation, possible alternative methods of treatment I hereby authorize the staff of (Institution) to undertake the stipulated procedure according to the study guidelines.

2. I have understood, by accepting to be included in this study, that photographs for personal identification and documentation will be taken at regular intervals.

3. Ihave understood the importance of being available for follow-up two years following the operation and the importance of informing the hospital of any temporary or permanent change of domicile.

4. I have understood the importance of contacting the hospital promptly if any of the manifestations illustrated prior to discharge should appear and that all additional treatment and transport costs because of forseeen and unforseen complications will be covered by the hospital.

5. I have understood that if I choose not to participate in the study I will recieve the best treatment available at this time.

Signed.

_____ _____

Patient Date

_____ _____

Relation Date

Annexure 4

MONITORING AND REVIEW
THE SOUTH ASIAN CATARACT MANAGEMENT STUDY

I.Monitoring of Study

1. Participating Centres

Each participating centre will conduct regular review of surgical procedure and immediate post-operative follow-up. If complications occur that leads to temporarily stopping of the study this must be immediately reported to the regional monitoring centre. The further inclusion of patients should only be done when there is a clear understanding of the cause of complication and this is rectified. A further trial period of a minimum of ten patients must precede further inclusion of patients. The following criteria for stopping temporarily the further inclusion of patients are suggested:

Surgical Procedure:

a)Intervention or implantation aborted in more than 5 consecutive cases or more than 10% of 50 consecutive patients.

b)Vitreous loss in more than 10 consecutive cases or more than 20% of 100 consecutive cases.

c)Severe intraocular bleeding in more than 5consecutive cases or 10% of 50 consecutive cases.

Immediate Post-Operative Period (prior to post-op. discharge):

If 5 consecutive cases or 10% of 50 consecutive cases have one or more of the following complications:

a)Severe postoperative uveitis with or without pupillary block & secondary glaucoma.
b)Postoperative Corneal Decompensation.
c)Severe hyphema
d)Gaping wound with prolapsed tissue
e)Prolapsed iris
f)Prolapsed vitreous to wound
g)Flat Chamber
h)Retinal Detachment
i)Secondary surgical Intervention
g)Explantation
h)Severe pressure rise (greater than 35mmHg)

2. SACMS Regional Office

The SACMS regional office will be responsible for the continuous monitoring of the quality of all data from all participating centres. One representative from the office (SACMS Adm. Coordinator or Programme Coordinator) will visit each centre at regular intervals (initially every 100 patient inclusions). The data will be reviewed with the study coordinator of p.c. cross checking IMAGEnet files with SACMS D-base files. Any inconsistencies between these will be defined and must be rectified. A standard reporting system will be used.Backup of new data (SACMS Database & Imagenet) will be taken and transported to the regional office.

The regional office will, after having collated data from all three centres, prepare a written report with tables and charts using a standard formula that will be communicated by fax to all three members of the review committee.

II Study Review:

The Review Committe will review the data at regular intervals - 1-2 months or evrey 100 patient inclusions.

1. The review committee will have the authority at anytime to stop inclusion of patients in the trial based on finding of its regular review. This shall be submitted in writing (fax) to the monitoring centre with instructions on what steps should be taken. The monitoring centre will then immediately communicate to the p.c. with the necessary actions to be taken.

2. The monitoring centre after a local review of the data may call a urgent meeting of the study coordinators to go through all the points taken up by the review committee. Necessary action must be taken by the study coordinator(s) viz. adjust routines or review surgeon performance.

3. A report will go back to the review committee that will then decide on wether to continue the trial, make further rectifications or abort the study.

4. The committee should convene a minimum of two meetings -once during inclusion of patients at the begining of the study and at the conclusion of the study when all data from end point are available.

SACMS MONITORING CENTRE REVIEW

Image Quality

Anterior Segment
1 = Poor:Cannot be used in assesement
2 = Good/Excellent: Can be used in assesement.

Endothelium:
1 Poor: No count or analysis possible;
2 Fair: Manual Count Possible
3 Good: Analysis possible

Ocular Status

Wound: 1 Gaping; 2 Tissue Prolapse

Cornea:
1a Opacification Grade 1a: moderate reduction of transparency (defined as loss of iris detail) of the upper quadrants of the cornea but not encroaching on the central optical area.
1b Opacification Grade 1b: moderate reduction of transparency (defined as loss of iris detail) of the lower quadrants of the cornea and encroaching on the central optical area.
2a Corneal Opacification Grade 2a: complete loss of transparency such that no iris detail can be defined of the upper quadrants but not encroaching on the central corneal area.
2b Corneal Opacification Grade 2b: complete loss of transparency such that no iris detail can be defined of the lower quadrants and affecting on the central corneal area.
CD=Corneal Decompensation:edema of cornea affecting both epithelium and stroma of an area not less than 3/4 of total corneal surface and must include the central optical area.

Anterior Chamber:
S Shallow: peripheral irido-corneal contact
F Flat Chamber: central irido or phaco-corneal contact
H Hyphema
H Hypopyon

Implant:
L Luxated: optic of IOL displaced away from optical axis of eye.
PW Prolapsed through wound:lens haptic and or optic in surgical wound.
PP Prolapsed through pupil:lens haptic and or optic in retro-pupillary space.
CT Corneal Touch: IOL in contact with cornea within 1 mm of limbus.

Iris:
IW Iris Prolapse to wound;
AS1 Anterior Synechi Grade 1:1 quadrant or less;
AS2 Anterior Synechi Grade 2: 2 quadrants or more;
PS Posterior Synechi: any posterior synechi;
IB Iris Bombe: bulging of iris in front of anterior pupillary plane in more than one quadrant

Pupil:
O Ovaling:any ovaling without decentration as defined below.
SP Seclusio Pupilae:posterior synechi 360 degrees.
OP Occlusio Pupilae:membrane obscuring view of fundus.
D Pupil Decentration: iris tissue drawn over optical axis.

MONITORING SHEET
(SACMS Monitoring Office)

Centre:______________________ Date:________

ID SACMS	ID IMAGENET	CELL QUALITY	AS QUALITY	WOUND	CORNEA	AS DEPTH	IMPLANT	IRIS	PUPIL	

REPORTING ROUTINES FROM THE SACMS REGIONAL OFFICE TO THE SACMS REVIEW COMMITTEE

The SACMS Regional Office will prepare two type of reports:

1. Regular Reports
2. Half Year Reports

1.Regular Reports (Every 4-8 Weeks)

These reports will cover approximately 100 new IOL patient inclusions and or follow-up.

The report will consist of two parts.

A summary of the activities and review of quality of data

A summary of activities in the reporting period will be given with notes on surgery,logistics/follow up and any special points on the conduct of the trial. The consistency of data will be reviewed with enclosed copy of the Monitoring Sheet for the that period.

Frequency Tables of crucial variables.

The SACMS database includes a monitoring facility that generates frequency distribution tables of the study variables.These are generated through a standard menu facility. These tables will be the basis for the regular reporting to the review committee.

The committee may ask for the distribution or proportion (count) of any variable but without any such request the frequency distribution of the variables related to adverse post-op reactions will be included:
The adverse reactions will be coded and entered into the following tables:

Immediate Post-Operative and between follow-up schedules:
Table iol_tret.
Optional Table A. Adverse Reactions (see below)
Optional Table B. Exam Period (see below)

Routine Follow-up (6 weeks, 12 months, 24 months)
Table iol_fup.
Optional A

2. Half Year Report

This report will be based on a thorough analysis after cross tabulations between the two groups (IOL & Control).

Age/sex distribution
Vision IOL and Control < 6/18
Vision and Complications
IOP
Surgical Complications/Immediate and Post-Op
Cumulative incidence rates of complications will be reported.
Endothelial Cell Count - IOL/Control
Biometrics (Based on Preop)

Review and Assessement of Consistency & Quality of Data.

PROCEDURE FOR REGULAR MONITORING

1. Consistency of Data Entry: Proformas
SACMS Database

Each patient folder will be scrutinized for consistency and entry errors. If editing is necessary this will be crossed out on Monitoring Sheet - Column Edit

2. Consistency of SACMS Follow-up data and IMAGEnet Documentation

All Anterior Segment and ID images will be reviewed for consitency of:

Patient Identification
Image Quality
Data Entry Errors
Agreement of Observations

1. Cell Images:

Preop and all Postop images will be reviewed.
A visual assesement of cell density will be done.
The folllowing guidelines will be used:

For cell densities greater that 2000:

If the difference between visual assesement and IMAGEnet Cell programme analysis is greater than 500 the analysis must be repeated and edited.

For cell densities less than 2000 greater than 1000:

If the difference between visual assesement and IMAGEnet Cell programme analysis is greater than 300 the analysis must be repeated and edited.

For cell densities less than 1000:

If the difference between visual assesement and IMAGEnet Cell programme analysis is greater than 100 the analysis must be repeated and edited.

Editing of cell density must be done only if there is agreement between study coordinater and programme coordinator.

Anterior Segment Images

All Post-Op AS images will be reviewed against SACMS Follow Up data entries. If inconsistencies arise patient folders will be consulted to determine the reason for disagreement: -errors of data entry
-observer error or variation

-If there is error of data entry the patient folder will be reviewed. If there is inconsistency between proforma and data entry the error should be rectified and edited in SACMS Database.

-If there is disagreemet of observation this should be noted in "monitoring sheet" using the code for observation at time of evaluation and data in SACMS Database. Ex 1A/NOA = SACMS 1A (moderate corneal opacification)/IMAGEnet No Observed Abnormality.

SOUTH ASIAN CATARACT MANAGEMENT STUDY

OPERATIONS MANUAL

AND

PROCEDURE GUIDE

I. PATIENT RECRUITEMENT AND INCLUSION IN TRIAL

Recruitement and Screening:

1.Patients will be recruited to the study through:-
i)outpatient ward of participating centre.
ii)outreach centres -primary health care or eycare (sub)centres.
iii)cataract screening camps in field.

2.The initial screening will be done with visual acuity testing and observation of anterior segment, cornea, ac and pupil (red relex). All patients with visual acuity less than 6/60 and bilateral cataract will be referred to the SACMS centre with a standard formula (see below).

I N C L U S I O N C R I T E R I A
MALE AND FEMALE 40 - 70 YEARS VISION LESS THAN 6/60 (0.1) INCLUSION EYE VISION 6\36 AND LESS BETTER EYE AGE RELATED CATARACT GRADE 2B AND 3

SACMS Preoperative Examination:

The preop exam will follow a standard routine for all patients outlined in the following table.

P R E O P E R A T I V E P R O C E D U R E	
P R O C E D U R E	INSTRUMENT
Patient Information	Pamphlet (Video)
Patient Reference&History	Preop Card
Vision	Vision Box
Cataract Assesement (Grading of Red Reflex)	Direct Ophthalmoscope (Undilated Pupil)
Endothelium Documentation	SL7F-Cell
Anterior Segment Photodocument ID Portrait	SL7F-AS Ion Camera
Patient Consent	Consent Formula
Data Entry	Preop Card SACMS D-Base

1.All patients will receive a standard information formula in the local appropriate language through a pamphlet, video or other medium while waiting to be examined.

2.The Ophtalmic asst. or secretary will take patient references and ask relevant questions on patients history.

3.Visual acuity testing wit vision box at 6 meters with best correction (sphere and pinhole).

4.Slitlamp Examination of Anterior Segment of eye ands measurement of intraocular pressure.

5.White to White Measurement

5.Grading of cataract after Minassian et al. grading system (dilated pupil).

CATARACT GRADING	
Grade	Criteria for Cataract Grading
0	Clear red reflex, no opacities.
1	Few small dot opacities in the lens appearing as tiny scattered dark spots in the red reflex. Maximum area occupied by the dots is 1mm square.
2a	Lens opacity obscuring part of red reflex. Area obscured is smaller than area of clear red reflex.
2b	As 2a but area obscured equal to or larger than area of clear red reflex.
3	Lens opacity totally obscuring the red reflex.
4	Aphakia or displaced lens.
5	Unable to assess red reflex, because of corneal opacity etc.

6. Review inclusion & exclusion criteria.

7. The patient is then asked to sign consent formula after having reviewed information pamphlet.

8. Endothelial cell photography on preop eye is performed at appropriate time.

EXCLUSION CRITERIA

GLAUCOMA

IOP > 26mmHg

CORNEAL DISEASE

OCULAR INFLAMMATORY DISEASE

SHALLOW ANTERIOR CHAMBER
(peripheral iridocorneal contact)

CHRONIC IRIS DISEASE OR MALFORMATION/DEFECT

ANTERIOR AND OR POSTERIOR SYNECHI

TRAUMATIC OR COMPLICATED CATARACT

NO PERCEPTION OF LIGHT

NO PROJECTION OF LIGHT IN 3 OUT OF 4 QUADRANTS

SUSPECTED HIGH MYPIA (GREATER THAN 6 DIOPTERS)

JUVENIL (TYPE I) DIABETES

ADULT ONSET (TYPE II) DIABETES WITH SEVERE BACKGOUND OR PROLIFERATIVE RETINOPATHY

ONE EYE

PSYCHIATRIC OR MENTALLY RETARDED

CHRONIC OR SEVERE SYSTEMIC DISEASE

CATARACT GRADE O,1,2a,4 AND 5

NO PUPILLARY REACTION (NPR)

II. SURGICAL PROCEDURE

SURGICAL PROCEDURE	
PROCEDURE	INTRUMENTS
Randomization	Envelope
Duration of Procedure	Stop Watch
Surgery	4X Loupes or Microscope
IOL Insertion	I-Gel/I-Micone Sheets Glide
Data Entry	Surgical Procedure Card
IOL Inventory	IOL logbook
Surgical Data	SACMS Surgery Log Book&Card
Enter Data on Surgical Card	Patient Sur Proc Card

The surgical approach will only be standardized in relation to choise of intraocular lens (Kelman Choyce Modification 4 Point Fixation (AC- IOL) and the use of introduction of intraocular fluids and viscoelastics.

IOL SIZE AND POWER:

Sizing the IOL:

The sizing of the IOL will be based on White-White Measurement which will be done during the preoperative examination. The patient will be scheduled for operation if the following IOL size is available. IOL Size greater than 0.5 W-W measurement in mm.

IOL Power:

The IOL manufacturer will be supplying a range of IOL power from 16.0 D to 22 D in 0.5 increments.
Centre 1 will choose IOL powver on clinical judgment.
Centre 2 will choose IOL power based on power calculation (Canon KU-1 IOL Estimator).

Surgical Complications: Procedure Guidelines

A. Threatened Expulsive Hemorrage:

If this occurs at any stage of the operation its treatment will receive overriding consideration.

B. Bulging Vitreous Face:

1. Check lids, rectus suture and any speculum to remove any extra ocular pressure.
2. Close wound and reform A.C. with AIR.
3. If it is impossible to insert implant, surgeon must use clinical wether to continue with lens insertion.

C. Vitreous Loss:

1. If one is sure of a complete anterior vitrectromy (round pupil and clear wound) it is not an absolute contra-indication for proceeding with lens implantation and insertion of lens should proceed as planned according to randomization. This is especially true when the lens has already been inserted into the anterior chamber in a case where removal may cause damage to the endothelium.

2. If one is not sure of acomplete anterior vitrectomy and if the eye has already suffred a great deal of handling, and if further handling and lens implantation would, in the view of the Surgeon, cause unjustifiable harm, he must desist from proceeding with the implanatation.

D. Hyphema:

1. Small hyphaemata do not cause problems and need not be removed or irrigated.
2. Large hyphaemata may cause fibrinous membranes on the lens. Therefor, if the hyphema covers the lens it should be reduced in size.

E. Eccentric Lens:

Slight torsion of iris sphincter or slight eccentricity of the lens will right themselves and do not require assidious attempt at correction.

F. Dislocated Implant:

This must be corrected and the decision to leave the implant in position must be made according to:-

a) wether serious further injury will occur to the endothelium or any other tissue.
b) wether it can be secured in position.

G. Aborted Lens Implantation

1. It must be appreciated by the participating Surgeon(s) that every attempt should be made to carry out a treatment designated for that patient. However, in the clinical situation, the Surgeon will occasionally consider it contrary to the interest of the patient to carry out lens implantation at the time of operation.

In that event it would be clearly unethical to proceed and the protocol allows the Surgeon to 'abort' the case. In the event of 'abortion' he should discuss the clinical situation with the principal investigator.

2.It has also to be pointed out that there are few absolute contra-indications to proceed with with implantation in patients randomized to intraocular lens and the situation is is largely dependant on relative factors. From the experience of Dr. Cheng (OCTET) comparatively few cases are aborted if the patient is considered eligible to have a lens implant using the criteria for inclusion and exclusion as defined in the protocol.

3.There will be two types of aborted cases:

i) those withdrawn from having lens implant before lens insertion is attempted beacause of anticipation of a complication.
ii) those withdrawn because the complication had actually occured and to proceed would, in the view of the Surgeon, be contrary to the interest of the patient.

III. POSTOPERATIVE EVALUATION

Each patient will upon discharge receive a I.D. Card with a post.op visit schedule (see below). The routine follow up schedule will be at 6 weeks: 12 months; 24 months.

The following routines will be followed at each schedule:

POST OPERATIVE PROCEDURE	
PROCEDURE	INSTRUMENT
Check Patient I.D. Check Patient Reference/Edit	Patient I.D. Card Page 1 Postop Card
Vision Testing PAC BPC	Vision Box & Trial Set Patients Available Correction Best Possible Correction
Endothelium Documentation Procedure for SL7F-E	SL7F-E 25X(16X) Magnification Imagenet Cell (T-Switch A)
Anterior Segment Evaluation Enter Data Anterior Segment Photo-Documentation	SL-7F-AS Page 2-3 Postop Card SL-7F-AS 10X Magnification Imagenet A.S. (T-Switch B)
IOP Measurement Applanation Tonometry	SL7F-AS with HS Applanation Tonometer
Fundus Evaluation Dilated Pupil CME Diagnosis (Optional)	Heine Direct Ophthalmoscope Tropicamide + Fundus Camera w. Fl.Angio
Enter Fundus and IOP Data Save Card	Page 3 Postop Card
Fill in Proforma Card in Folder	

1. DIAGONOSTIC UNIT

1.1 COMPUTERS: GENERAL INFORMATION

SACMS will in each centre have two main systems implemented to administrate the research work. These two systems are as follows.

- **SACMS DATABASE SYSTEM (BASED ON PARADOX)**
- **IMAGENET SYSTEM (FROM TOPCON, EUROPE)**

Besides the two above mentioned systems, an independant computer will be installed in each centre to be used for other purpose with other programme like WORD PERFECT, EPI-INFO, SIGMA PLOT, HARVARD GRAPHICS and other.

If serious problems should occur, the operator must contact the regional office Kathmandu. It is strictly prohibited to install any user programmes in the computer containing imagenet and the cataract management database system except in the independent computer available for user programmes.

Unauthorised persons must not have access to the project computers and systems as well.

SACMS DATABASE FOR PATIENT MANAGEMENT SYSTEM

HARD-WARE EQUIPMENTS:

1 Acer 386/20 Mhz with 4 Mb RAM, 100 Mb Hard Disc, 14" MVX HITACHI Monitor
1 HP Laserjet iip plus connected with imagenet system machine through a autoswitch box.

SOFT-WARE PROGRAMMES:

- MS-DOS version 5.0
- PARADOX Runtime version 3.5
- QEMM Memory management programme
- SACMS Database programme(specially developed)

DOCUMENTAION MATERIAL/USER MANUALS ETC

- MS DOS Manual
- SACMS Manual

IMAGENET SYSTEM:

HARD-WARE EQUIPMENTS:

1 ACER 387/25 Mhz PC with
8 Mb RAM, 200 Mb Hard Disc,
14"MVX HITACHI Monitor
UK Keyboard, IBM PS/2 Mouse
1 14" SONY Colour monitor
1 Optical drive with 900 MB Optical disc.
1 Switch box with two lines A and B.
2 Full slit lamp system
1 HP Laserjet iiiplus connected with SACMS Database machine through a autoswitch box.

SOFTWARE PROGRAMMES:

- MS-DOS version 5.0
- DBASE Database programme runtime version
- Reflections driver for optical drive.
- QEMM Memory menagement programme
- Norton Utilities
- Imagenet VERSION C (Developed by TOPCON- JAPAN)

DOCUMENTATION MATERIAL/MANUALS ETC

- MS DOS manual
- Reflections driver manual
- HP Laserjet printer manual
- IMAGENET Manual
- SLITLAMP Technical manuals
- SONY Colour monitor manual
- Mouse driver manual

1.2. SACMS DATABASE REGISTRATION AND MONITORING SYSTEM

1. General Introduction

The data registration software package is designed by the Operations Research Unit of the Institute of Community Medicine (T.Snellingen), University of Tromsø and is developed using the PAL programming facility of Paradox 3.5 by E. Kureghian of London. A digitalized photodocumentation storage and retrieval system (IMAGEnet) will be used to allow for a functional system of monitoring of the quality of data using standardized techniques (Chapter 3).

The system is designed for the management of cataract survey data with special focus on intracapsular cataract surgery (ICCE) with and without IOL. The registration system can, with small modifications, be adapted to extracapsular cataract surgery (ECCE) by making use of the optional fields (posterior capsule, IOL capsular centration etc.).

2. Database Structure

The database is organized with the help of a menu system that guides the user to the different sections of the database. The structure can be reviewed anytime by selecting the database "tree" menu on the Main-Menu option Select Tree and hit return:the Database "Tree" will appear on the screen.

3. General User Description

STARTING PROCEDURE OF THE PC:

- Press the POWER button. (The Computer will give a starting noise.)
- Press the POWER on your Hitachi Monitor.
- The starting MENU to start the Database will show up in the SCREEN.

STARTING PROCEDURE FOR DATABASE

STARTING FROM MENU.

- Select the right MENU to start the Database by using UP and DOWN ARROW and hit RETURN. You will now have the first picture of the SACMS database on your SCREEN. Herafter, you will have to follow the MENU which appears on the top of the SCREEN. The first line with capital letter (INVERSE light) shows the name of MENU (All in capital letters) you can choose. (Example: DATA-ENTRY, EDIT,VIEW etc.).

You move your CURSER from one MENU to another either by pressing the first CHARACTER of the MENU or by using RIGHT or LEFT ARROWS in the KEYBOARD. The second line is reserved for the FUNCTION KEYS like F1 to get help, F2 to save and resume data and so on.

These FUNCTION KEYS are very useful when you are using the database. F.ex. If you do not know how to move from one SCREEN to another, you get information by pressing the F1 KEY. You should read it carefully so that you will get familiar with the functoinalities available in the system. To remove the HELP information from your SCREEN press the SPACEBAR key. Details on using DATA ENTRY containing MENUs like "PRE-OPERATIVE", "SURGICAL PROCEDURE", "FOLLOW-UP" etc are explain in chapter 2.2. (See later)

UNDERSTANDING THE CURSOR MOVEMENT WHILE USING SACMS DATABASE:

After you have entered the DATA on a defined field:

1. If you hit RETURN means the programme activates a logical check. If the value is correctly entered the CURSOR will automatically move to next field.

2. If you move to next or any other field by using LEFT/RIGHT/UP/DOWN ARROWS the logical check has not been done. This facility is only available between the non-compulsøry fields.

3. There are many OBLIGATORY fields where you **must** enter the data. If you try to move from obligatory field to the next field, the CURSOR will reject to do it.
You shall get a clear message on the SCREEN explaining what action you are suppose to take. This message will be shown in the bottom line of the SCREEN in (INVERSE VIDEOmode). Do not get Panic to have this message.

4.If you want to move from one SCREEN to another, you can choose different alternatives. By pressing CTRL + HOME keys brings your CURSOR in the begining of first picture. CTRL + END brings your CURSOR to the last picture. Remind that CTRL + HOME means, hold the CTRL keys down and hit HOME key on your keyboard. The same system applys for using ALT key functions. These functions may be very helpful if you have entered wrong values in the previous field and you want to correct it before you hit F2 key to store the data.

5. To ERASE/DELETE the wrong values you have entered in the field, use the <--- key (left to INSERT key).

6. Finally, when you have completed your DATA ENTRY you will naturally hit the F2 key to save the card. The SYSTEM will activate a full LOGICAL CHECK before the record is saved in the Hard Disk. If the check gives you an error message you will have to review the data that you have entered. Normally the CURSOR will remain in the field where the WRONG VALUES has been entered.

STARTING FROM DOS

- If just in case the MENU system is out of Function, you can start your Database from DOS Prompt by typing cd iol -ENTER- IOL and hit RETURN. The SACMS database will now start. After this the same procedure as it mentioned in the previous page.

STOPPING/LOGGING OUT PROCEDURE

- Log out the DATABASE correctly by pressing ESC key. Continue to hit ESC until you get the MAIN MENU OPTIONS on the SCREEN. Select the MENu options LEAVE and hit RETURN. You will now be asked by the system if you realy want to EXIT from the DATABASE. Move CURSOR to YES and hit RETURN.

You are now LOGGED OUT of DATABASE and the MAIN MENU will appear in the SCREEN. You can now put off the computer if you like. This will be the normal procedure to stop the COMPUTER after working day is over.

4 BACK-UP PROCEDURE

To run the BACKUP procedure of the SACMS database, following will be the routines.

1.Daily backup (1 Formated floppy each day and re-use it every monday)

2.It is recommended that the daily backup procedure is done at the end of the workingday.

Every centre will be supplied 10 - 15 floppies which shall be used to BACKUP and other COPY purposes.

The FLOPPIES will be of type: 3 1/2" size and DS,DD. These FLOPPIES have a capacity of storing 1.4 mill. bytes (Bytes = characters, example: +,-,abc). These floppies are not allowed to supply or to be used to other computers except for the SACMS project computers. The reason is to avoid any other SYSTEM formating or to secure the DATA as well as avoiding the COMPUTERS VIRUS problems.

Always keep the FLOPPIES in the FLOPPY CASSETTE after use.

Running Backup Job:

1.Log out from the DATABASE (See Logging out procedure).

2.FORMAT the choosen FLOPPY by selecting the MENU FORMATING THE FLOPPY in the Main Menu (Nr. 2).Formatting means to prepare the DEVICE in a correct way (as the DOS SYSTEM demands) so that the SPACE,TRACKS,CYLINDER,MARKS etc in the FLOPPIES or Hard Disc will be correctlly structured.

WHEN YOU RUN A FORMATING COMMAND, ALL PREVIOUS INFORMATION ON FLOPPY OR HARD DISK (WHICH DEVICE YOU ARE FORMATING) WILL BE DAMAGED AND RETRIEVE POSSIBLITIES WILL NOT FUNCTION. IT IS THEREFORE EXTREMELLY IMPORTANT THAT YOU ARE FOLLOWING THE PROCEDURE CORRECTLLY.

3.Follow the message in the SCREEN. You will be asked to insert the FLOPPY disk in the DRIVE A:

4.Insert the choosen FLOPPY in the DRIVE A: and hit RETURN. The formating process will now run.
It will take about 1 1/2 minutes. During the formating process is running, you will be asked "Volume label (11 character, Enter for none)? Just hit RETURN. The formatting of the FLOPPY is now over and you will be asked to format next FLOPPY. If you want to format many FLOPPIES answer Y and hit RETURN. You will be asked to mount the NEW FLOPPY. Insert the next one and hit RETURN. You can continue this process if you have many FLOPPIES to format.
If not answer N and hit RETURN. The formating process will now be end and you will be back to the MAIN MENU. Dismount the FLOPPY from the DRIVE A:
5.To take the BACKUP of the DATABASE, you will now have to start the programme again by selecting the starting of SACMS DATABASE MENU.

6.Select the BACKUP MENU (next to REPORTS) in the MAIN MENU OPTIONS and hit RETURN. Follow the message in the SCREEN. You will be asked to MOUNT a newly FORMATED FLOPPY in the DRIVE A:

NAME THE BACK UP FILE WITH DAY OF WEEK A:Mon: A:Tue, etc..

If you have done this, hit RETURN. The BACKUP process will now run.

REMEBER THAT THIS BACKUP PROCEDURE WHICH STARTS FROM THE MAIN MENU OPTIONS OF THE SACMS DATABASE WILL ONLY COPY THE FILES TYPE DB. THESE ARE THE FILES WHICH CONTAINS THE DATA YOU HAVE ENTERED BY USING DATA ENTRY MENU. MARK THE FLOPPIES YOU HAVE USED WITH DATE AND TIME. DO NOT FORGET TO PUT YOUR SIGNATURE ON THE TAG.

---

5. GENERAL MAINTENANCES AND TROUBLESHOOTING FOR IMAGENET AND SACMS DATABASE SYSTEM

- KEEP ALWAYS YOUR COMPUTER AND THE OTHER PERIPHERIAL EQUIPMENTS CLEAN. KEEP ALSO YOUR COMPUTER ROOM FREE OF DUST AND LIQUID.

- KEEP ALWAYS THE BACKUP FLOPPY DISK IN THE FLOPPY DISK BOX WHEN NOT IN USE.

- REMEMBER TO TAG THE BACKUP FLOPPY DISK CORRECTLY WITH DATE AND TIME (IF POSSIBLE) ON THE COLOUR TAG.

- AVOID PLACING YOUR COMPUTER AND THE RELATED EQUIPMENTS DIRECTLY AGAINST THE SUNSHINE.

- KEEP THE COPY OF FOLLOWING FILES IN A SEPERATE FLOPPY DISK.THIS FLOPPY WILL BE VERY USEFUL TO RESTART THE COMPUTER IN CASE THE COMPUTER FAILS TO START. THE FILES ARE:

  1. AUTOEXEC.BAT
  2. CONFIG.SYS
  3. COMMAND.COM

- IF YOU ARE EXPECTING THAT THE ELECTRIC SUPPLY SYSTEM AT YOUR COMPLEX WILL BE CUT OFF, REMEMBER TO OUT OFF ALL EQUIPMENTS BEFORE THIS SITUATION TAKES PLACE. THIS WILL AVOID DEFUSING, DAMAGING HARDWARE EQUIPMENTS PROBLEMS.

6. Using the Data Entry System

The following section will guide the user through the data entry section of the SACMS Database including a guide to definition of study variables.
These definitions can be easily reviewed py hitting the F3 function key during the dataentry procedure. The definition of the variable corresponding to the position of the cursor will appear on the screen.

When turning on your SACMS Computer a menu will appear on the monitor. Select "Starting SACMS Database" and hit 'Enter' key. The opening screen of the database will appear.If this opening page does not appear there is a configuration error in the operative system - **see chapter 2.3 or c o n t a c t the SACMS Monitoring Centre.**

Press any key to enter the **Main Menu Options:**
This menu gives an overview of the main sections of the Database.

1. Data Entry Section:

This section gives the enumerator the access to the data entry for all study schedules: PREOPERATIVE = 2 pages; SURGICAL PROCEDURE = 2 PAGES;POSTOPERATIVE EXAMINATION = 5 pages; POSTOPERATIVE CARE = 2 pages.

2. Edit:
This section gives the user the option of editing previously saved cards.

3. View:
This section gives the user the option of viewing previously saved cards.

4. Print:
This section will allow the user to printout patient data and proforma cards.

5. Back-Up:
Incremental AND MONTHLY back-up of database to floppy disk (see 2.6).

6. Reports:
This section includes all reporting procedures: patients schedules and monitoring.

7. Tree:
Give the user a easy access to the complete structure of the SACMS Database.

PATIENT DATA ENTRY CARDS (Proformas):

Select 'Data Entry; and Hit 'Enter'

You have noe entered the data entry section.
Each Data Entry Procedure -ex. Pre-Operative-Exam- will be described as a (proforma) card. Each proforma card includes 2 or more pages (1/2,2/2..) with different sections (A,B,C..)

The data entry section is programmed with multiple checks and controls to reduce the possibility of punching error. On saving the card at the completion of the entry a logical check is made before the card is saved to the hard disk. You have easy access to the instructions on movements once entered into any card by hittingthe F1 key (see also chapter 2.3.).

I.Pre-Op: Preoperative Examination:Inclusion Card with Corneal and Biometric Data.
II.Pre-Op-Endo:Preoperative endothelial cell analysis data.
II.Surgery:Surgical Procedure
III. Follow-UP: Postoperative Examination -Evaluation Card: 6 weeks;12 months;24 months.Each card consists of different sections containing boxes to be filled in with two types of data.
IV.Follow-Up ENDO: Postoperative enothelial cell analysis data.
V.Treatment: Postopretaive Management Card

Two types of data will be entered into the data base:

1.Numerical Data (Continues Variables): Represented by single lined boxes

..digits

Card Number, Date, Age , etc.

2.Categorical Data (Yes or No): Represented by double lined boxes

Sex,Vision,Complications,etc.

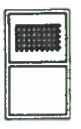
Yes No

EXAMPLE

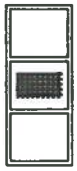
Card Number

(numerical)

Sex



Vision



(categorical)

Select Pre-Operative-Exam on Data-Entry Menu Options and hit 'Enter. Page 1 of the Pre-Operative-Exam Card will appear on the screen.

I. PREOPERATIVE EXAM:Inclusion Card

The Pre-Operative-Card includes the following pages and sections.

1/1 Reference Section - page 1
1/2 Patient Identification - page 1
2/2 Vision - page 2
2/2 Intraocular Pressure - page 2
2/2 Corneal and Ocular Biometric Data - page 2

PAGE 1

A) Reference Section:
This section relates the centre & patient (ID number), to the particular date, examiner and the enumerator (the individual entering the data).

The first digit (c.code=centre code) is allocated to each participating centre (1-3) and is then fixed giving each patient in the study a unique 5 digit code (10001...39999). At each new entry the next patient number is entered serially 10001..10002..10003..1000n.

B) Patient Identification:
This section relates the ID number to the personal details of the patient:name, sex, etc.
Predefined fields: (Can be eneterd directly or reviewed and entered by hitting the F3 Function Key).
Ethnic Origin: Aryan;Mongolian;Dravidian,Other; **Admin.Unit:** Defined by each participating centre;
Occupation: Farmer,Fisherman,Housewife,Service,Business, Skilled Laborer,Unskilled Laborer, Other.

PAGE 2

A) Vision/Correction

This section gives information on the patient best corrected vision. If the best vision is obtained unaided then the correction section is left blank.
An open section is spared to note the patients own correction. This willnot be registered in the database.

Note: The Correction Fields will only accept values +/- 6.

B) Intraocular Pressure (1-2 digit value). Obligatory fields.

C) Corneal and Biometric Data (Axial Length):

The data for this section is an optional section for corneal and ocular biometric screening and power calculation and will only be used routinely on patients included in biometric substudy.

II.Pre-Op Endo:

This menu selection gives access to the Preoperative Endothelial Cell Data. Select Pre-Op Endo and hit return. Type 5 Digit ID No and the appropriate screen will appear.

Enter examiner and enumerator code and entry date.
Enter all relevant data from Printout of Cell Analysis (IMAGEnet). Only the Endothelial cell density is a obligatory field. The remaining fields are optional.

III. SURGICAL PROCEDURE

Select Surgery on Data- Entry Menu Option and hit return. The following message will appear on the screen (see above):Type patient ID Number (5 digits).

SURGICAL CARD PAGE SECTIONS

1/2 Reference Section - page 1
1/2 Surgery Details - page 1
1/2 Surgical Procedure - page 1
2/2 Abortion of Procedure - page 2
2/2 Complications - page 2
2/2 Optional

PAGE 1

A) Reference Section:
Gives the patient reference data filled out on preoperative exam.

B) Details of Surgery:

Date: Date of Surgery; **Surgeon Code:** Puncher Code

Mins.: Duration of surgery - mins-: the time elapsed (in minutes) from the eye is open (from perforation of eye first incision) to the eye is closed (last closing suture recorded with a stopwatch.

Eye: Randomization of Patients
Based on information in sealed envelope.

REMEMBER! THE ALLOCATION OF THE PATIENT IS LOCKED REGARDLESS OF OUTCOME OF SURGERY

I: Randomized to IOL Implantation
N: Randomized to No IOL

IOL-#:iol Batch Code; **White-White:**White to white measurement using calipers.

IOL-Size: Length of IOL in mm. Predefined 12.5 mm, 13.0 mm, 13.5 mm.;
All data pertaining to IOL.

IOL-power: A value from 18.0 D - 21.5 D in 0.5 increments.

C) Surgical Procedure

Anesthesia: Mutually exclusive fields;

IOP Reduction: Mutually exclusive fields;

Section: Mutually exclusive fields;

Lens Extraction: Mutually exclusive fields;**Iridectomy:**Mutually exclusive fields;**Solutions:** All entries allowed.

(Mutually exclusive fields: only one variable in particular section can ve chosen)

PAGE 2

A) Abortion

Abortion of Procedure: No Cataract Extraction Performed;
Abortion of Lens Implantation without lens discard:
Cataractous lens extracted - implant insertion not attempted;
Abortion of Lens Implantation and lens discarded: Cataractous lens extracted
lens implant attempted but aborted.

Abortion fields mutually exclusive.

B) Complication

Complication fields: All entries allowed.

IV. FOLLOW-UP EXAMINATION

Select Follow-Up-Exam on the Data Entry Menu Option and hit return. On entering the follow-up exam section from the Data Entry Menu the programme will ask you to type the patient ID number. Enter the patient reference number and hit return key.

A message will appear on the follow up exam status of the patient concerned.

Press any key to start follow-up data entry programme...

.

FOLLOW-UP SECTIONS

1/5 Surgery and Preop Data of Patient
1/5 Personal Details
2/5 Vision: Patient's Available Correction (PAC)
2/5 Vision: Best available Correction (BAC)
3/5 Ocular Status:Conjunctiva;Wound;Cornea;Anterior Chamber
4/5 Ocular Status:Implant;Iris;Pupil
5/5 Ocular Status:Corpus Vitreum;Fundus
5/5 Intraocular Pressure
5/5 Current Action Needed
5/5 Optional

PAGE 1

A) Reference Section:

Surgery and Pre-Operative Data: (see above).

B) Reference Section Current Follow-Up:

Date;Examiner;Enumerator: As before;

Exam Status:
This is a special follow-up card field with predefined entries:
Exam Status 1: Examined at SACMS Centre; Exam status 2: Examined in Field;Exam status 3: Examined in Field and Centre.

C) Follow-Up Exam Personal details: This is a check and edit section of the patient that must be reviewed at each follow-up.

-No Changes In Patient Personal Details: Hit Function Key
-Change In Patient Personal Details: Edit this section

PAGE 2

A) Vision PAC: Vision with Patients Available Correction:

The visual acuity is tested with whatever correction is available with the patient on presentation to the exam. This represents the patient's practical vision.

B) Vision BPC: Vision Wwth Best Possible Correction:

The visual acuity is tested with the best spherical correction with pinhole using SACMS trial box.

PAGE 3

A) OCULAR STATUS:Conjonctiva

No Abnormality;Red Eye:any redness of the bulbus.

B) OCULAR STATUS:Wound

No Abnormality;Gaping;Tissue Prolapse: any prolaps of intraocular tissue.

C) OCULAR STATUS:Cornea

No Abnormality

Opacification Grade 1a: moderate reduction of transparency (defined as loss of iris detail) of the upper quadrants of the cornea but not encroaching on the central optical area.

Opacification Grade 1b: moderate reduction of transparency (defined as loss of iris detail) of the lower quadrants of the cornea and encroaching on the central optical area.

Corneal Opacification Grade 2a: complete loss of transparency such that no iris detail can be defined of the upper quadrants but not encroaching on the central corneal area.

Corneal Opacification Grade 2b: complete loss of transparency such that no iris detail can be defined of the lower quadrants and affecting on the central corneal area.

Corneal Decompensation: edema of cornea affecting both epithelium and stroma of an area not less than 3/4 of total corneal surface and must include the the central optical area.

D) OCULAR STATUS:Anterior Chamber

No Abnormality

Shallow: peripheral irido-corneal contact

Flat Chamber: central irido or phaco-corneal contact

Cells + : occasional cells observed after carefull search

Cells ++ : sufficient cells to be seen readily

Hyphema

Hypopyon

PAGE 4

A) OCULAR STATUS:Implant

No Abnormality: no displacement and no deposits

Luxated: optic of IOL displaced away from optical axis of eye.

Prolapsed through wound: lens haptique and or optic in surgical wound.

Prolapsed through pupil: lens haptique and or optic in retropupillary space.

Corneal Touch: IOL in contact with cornea within 1 mm of limbus.

B) OCULAR STATUS:Iris

No Abnormality;

Iris Prolapse to wound;

Anterior Synechi Grade
1: 1 quadrant or less;

Anterior Synechi Grade 2: 2 quadrants or more;

Posterior Synechi: any posterior synechi;

Iris Bombe: bulging of iris in front of anterior pupillary plane in more than one quadrant

C) OCULAR STATUS:Pupil

Ovaling:any ovaling without decentration as defined below.

Seclusio Pupilae:posterior synechi 360 degrees.

Occlusio Pupilae:membrane obscuring view of fundus.

Pupil Decentration: iris tissue drawn over optical axis.

PAGE 5

A) OCULAR STATUS:Corpus Vitreum

No Abnormality:

Cells +: cells observed with slitlamp in anterior vitreous cavity.

Hazy: Hazy vitreous with reduced transparency and loss of fundus detail.

Opaque: No red reflex and complete loss of transparency.

B) OCULAR STATUS:Fundus

No details:any loss of transparency pf ocular media reducing detail of macula and optic nerve.

Retinal Detachment: any degree of detachment

Optic Atrophy: Pathologically pale optic disc.

Macular Scarring or Degeneration:

Cystoid Macular Edema (CME):defined after observed leakage of fluorescein typical for CME.

V. Follow-Up-ENDO

This menu selection gives access to the follow-up

Endothelial Cell Data. Select Follow-Up-ENDO and hit 'Enter'.
Type 5 Digit ID No and the appropriate screen will appear.

Enter examiner and enumerator code and entry date.
Enter all relevant data from Printout of Cell Analysis (IMAGEnet).

VI. TREATMENT
This card will be used for:
1. All patients upon discharge.
2. All patients that have complications thath neccesitates medical or surgical treatment.

Select Treatment on Datentr Menu and hit 'Enter'. Type ID Number of patient whose Treatment Data is to be entered (5 Digit Number). Hit 'Enter'.

Section A: Preop and Surgery Data
Section B: Treatment Details
Section C: Medical Treatment
Section D: Surgical Procedure

1.3. IMAGEnet SYSTEM

1 Introduction

The Imagenet Photodocumentation system is a complete imaging system for image capture,storage,retreival and analysis. Please review the relevant sections in the IMAGEnet User Manual(c) for Complete User Instructions.

The Imagenet used in the SACMS will alllow for a comprehensive monitoring of patients data entered into the SACMS Database. Routine photodocumentation will be done of Anterior Segment and Corneal Endothelium on all study eyes at pre-operative and post-operative schedules.

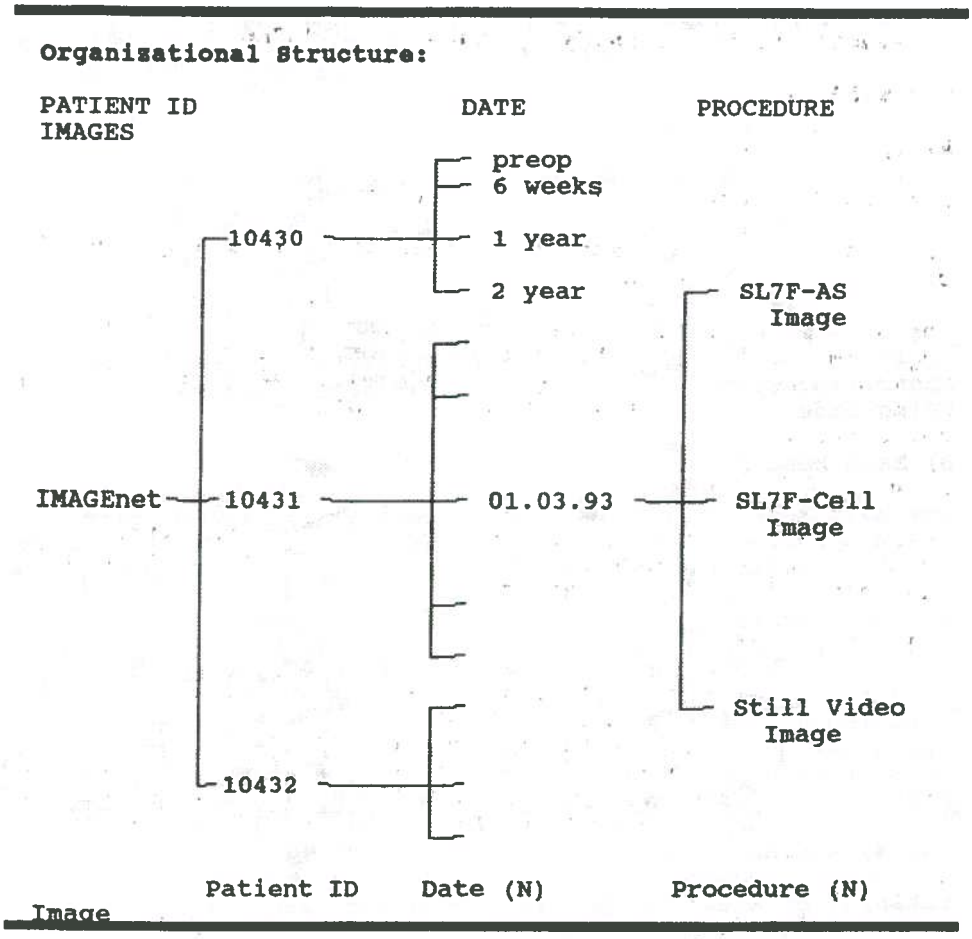
The Monitoring Centre will review the quality of the data at regular visits to the participating centres cross checking SACMS DB files and Imagenet files.

2. Data Base Structure (see chart next page).

The SACMS Imagenet System is Version C (Cell) 3.2. This version includes a complete cell analysis programme that gives the capability of automated analysis of endothelial cell images using the SL7-F Slitlamp set at 25X magnification mounted with a specular. For a description of the complete system see 1.?.

The Imagenet database is a complete windows based user friendly system that guides the user through the diffrent procedures with the help of menu options.

The database has 3 main components:
i) Database for patient references (D-base)
ii) Imagenet picture storage facility
iii) Complete Endothelial Cell Analysis Programme
iv) Miscellaneous



IMAGEnet Database Structure

3. General Description:Using Imagenet in SACMS

STARTING UP:

A) Opening Screen..

Turn On Imagenet System in Right Sequence.

The system will take some 15 seconds to perform a series of computer systems check.

The screen above will appear on the monitor simultaneously as logo (IMAGEnet - TOPCON) will appear on the Sony Video Monitor. The first screen gives information on participating centre and system configuration. The image file map si now being made.

B) Main Menu Screen.

The Main Menu Screen gives you access to all the different functions of the IMAGEnet System. Use the arrow keys to select the menu option desired and hit return.

F12 Options Menu:

By hitting the **F12** function key you will access the options menu for special functions. You can use this menu or the corresponding function key to activate the different sub menu. Only the F1 -Display Format- and F2 -Disk Info- can be entered on the Main Menu Screen. For the other options (F2-F10) there must be a image displayed on the Sony Monitor.

The Main Menus:

FLASH: Gives acess to the flash mode for image capture with SL7F-AS and FL7F-Cell.
SLIDE: Gives access to the transfer of Still Video pictures from the field (ION CAMERA)
DISPLAY: Give access to review and analysis of stored images.
PATIENT: Gives Access to reviewing and editing patient data files.
UTILITY: Gives access to diffrent utility functions: List;Copy;Delete;Inquiry;Media
EXIT: Select and hit return to exit IMAGEnet database.

THE FLASH MENU

On entering the Main Menu Screen the cursor is over FLASH. Just hit return to activate Flash Programme. A Patient Identification box will appear on the above right hand side of the screen.

Entering A New Patient:

When entering a new patient the patient will have to be registered with the IMAGEnet system.
Type the ID number (SACMS 5 digit unique number) ex -1111- and hit return. The patient registration menu will appear on the monitor. You will notice that the ID Number has now been registered. Fill in the patients full name. To move around this card use the up and down arrow keys. NOTE:The small box to the right of the for the patients name will be the randomization code (I or N) to be filled out on first post-operative schedule.

Hit return key - the programme will ask you to check all entries before saving. Check entries and hit return key - patient is now registered and THE FLASH AQUISITION MENU (TAKE FLASH PHOTO) will appear.

Note that your patient is now registered in the IMAGEnet database (Blue Box - Upper Left Corner)

THE FLASH AQUISITION MENU SCREEN

Blue Box Upper Left: Patient ID and Details.

Purple Box Below Left: Eye:Give info on eye to be photographed-hit retrun or F1 function key to choose eye to be photgraphed.

Disk Info: Gives info on buffer,image taken,disk space available,and on current image.

Black Box Upper Right:Instrument and Aquisition Status (ready or unable to take image)

Blue Box Lower Right:Options Menu for Image Manipulation: Review,Save,Delete,Disk Info, Exit.

CHOOSE EYE TO BE PHOTOGRAPHED <OD> or <OS>

YOU ARE NOW READY TO TAKE IMAGES WITH THE SLITLAMP

GO THROUGH THE IMAGE CAPTURE PROCEDURE:AS OR CELL

REVIEWING IMAGES:

You can take a total of 26 images (Buffer Size) in one session. You will rarely need more than 10 frames for each session. When finished with one session. Hit F4 Review/Edit on the options menu for image manipulation and storage.
A Purple Box will appear and guide you through different procedures for viewing images on the Sony Monitor.

Show Proof Sheet: This will give you a overview of all the images taken with a possibility to select a desired image with the mouse and cursor. Move the cursor with the mouse over the picture you wisk to see and press the middle mouse button. The image chosen will appear on a full screen. Use Page Down/Page Up to move between pages of proof sheet.

Forward Frame: To move to next frame.
Reverse Frame: To move to former frame.
Scan Frame Forward: The programme will scan the whole proof sheet automaticaly.
Show First Frame: Will jump back to first frame.
Show Last Frame: Will jump forward to last frame.

DELETING/SAVING IMAGES:

When you have reviewed the quality of the images taken you can delete the images you do not wish to save from the buffer and then save the best image to OPTICAL CARTRIDGE.

REMEMBER ONLY SAVE ONE ANTERIOR SEGMENT AND ONE CELL IMAGE FOR EACH PATIENT

To delete an image place the cursor using the mouse over image and press hit delete key - the image is marked -delete-. Press escape twice to access Flash Menu Options.

To store image hit F5 to store image to hard disk(Winchester), Hit F6 to store image on optical cartridge. If you are storing more than one image on a file the programme will ask you to create proof sheet - comment:type **PREOP, EXAM 1..2..3** according to schedule.

THE SLIDE MENU:

This function allows the incorporation of images from slides and other external sources and will be used only to include slides taken with film camera.

BACK-UP ROUTINE:
Store image to optical cartridge after deleting unwanted images from memory. At close of days session copy images to hard disk (Winchester) from optical disc using copy function on utilities menu.

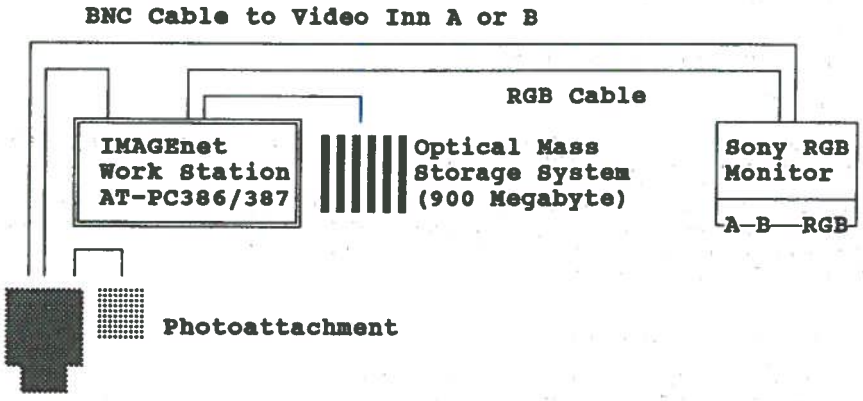
1.4 Endothelial Photodocumentation and Analysis System

This system is an integral software package for Endothelial Image Capture, Storage/Retrieval and Analysis System.
It includes two components:

1. Specular Microscope: A SL-7F Slitlamp mounted with a non-contact specular attachement and connected to a flash unit.

2. IMAGEnet hardware and software package.

Check settings for system (see below).
Follow procedure guide for endothelial image capture below (see the procedure described in IMAGEnet General Description) and go through procedure for enothelial cell photography.



Slitlamp SL-7F with Specular Attachement

INSTRUMENT ADJUSTMENTS and PHOTOGRAPHY:

SL-7F CELL			
INSTRUMENT	**FUNCTION**	**Adjustment**	**Photography**
CAMERA	Relay Lens Diaphragm	11mm	11mm
SL7F-CELL	Magnification Slit Width Slit Length	25X 9mm (0.2) 20mm	25X 2mm 7mm
FLASH UNIT	Flash Intensity		2-(3)
IMAGENET	Flash Menu F12	Input Channel Top	

Slitlamp Adjustments with Non Contact Specular Device:

1. Mount test rod. Adjust angle between the illumination arm and microscope arm to 45 degrees. Microscope arm at 90 dgrs.

2. Dioptric Adjustments.
Carry out dioptric adjustments as is done for regular objective lens. Insure the the eyepiece with the cross scale is on the right side. The slits of the mask can only be observed in the right ocular.

3. Focus Adjustment.
Increase the slit width (9) until the complete field of view can be seen. Set the magnification changer setting to 25X. Loosen the objective lens fixing screws and rotate the objective lens in or out until the image on the test rod is focused sharply. Tighten the objective lens fixing screw.

4. Alignment of the Line of Sight.
Adjust the slitwidth to 0.2 mm. Adjust the slit image with the objective lens holder lateral adjustment screw until it is centered (as far as possible) in the field of view. Ensure that the arms of mask ar centrally located in the field of view.

Endothelial Cell Photography -Finding the Specular Cell Image:

1. Check angle between slitlamp and illumination arm (45 degrees).

2. Adjust the slit width to 2mm with s.w. adjusting knob
and the slith length at 7mm with slit diaphragm plate handle.

3.Set magnification to 25X position.

4.Position objective lens so that the corneal reflection is placed to the right of the optical axis and incident rays penetrate the central pupillary axis (objective lens positioned approximately 15mm from the cornea).

5.Move joystick carefully a few mm back and forth along optical axis. Search for bright corneal reflection (flash) looking in the right ocular. Move bright reflection towards left by moving joystick carefully forward a few mm. until reflection is under the mask and observe endothelial cells. Focus sharply and shoot serial frames at short intervals. Review images using review/edit function on Flash Aquisition Menu (F4).

3.5 Anterior Segment Photodocumentation System

Continues Monitoring System and Quality Control of Anterior Segment Observations.
IMAGEnet System with RBG and SL-7F AS 10X Magnification.Follow procedure guide for AS Photodocumentation below (see procedure described in IMAGEnet - General Description).

Slitlamp SL-7F For Standard AS Imaging

INSTRUMENT ADJUSTMENTS

SL-7F ANTERIOR SEGMENT (AS)		
INSTRUMENT	**FUNCTION**	**SETTING**
SL7F-AS FLASH UNIT	Magnification Slit Width Slit Light Flash Intensity	10X 2
IMAGENET	Flash Aquisition Mode Ant.Segm.	F12 MIDDLE

3.6 Still Video Camera (ION) **Identification System**

The ION Camera is a still video camera capable of storing up to 50 frames on small removable cartridges. The frames can be transfered to the IMAGEnet System using the Slide Menu Option.

The ION Camera will be used as :

1. Patient ID: ION image of patient stored in Ant.Segment File.
2. Patient verification to be used in mobile kit to be used as alternative source of photodocumentation and patient ID of patients who are not able or willing to visit the Main Centre.

Using the Ion Still Video Camera:

1. Charge battery cell with battery charger.

2. Load battery and casette.

3. Erase existing frames on casette with Erase All Function.
   (Sett main switch on PLAY/ERASE. Hold down Mode/Erase and All Erase and press down trigger button).

4. Sett to record mode when taking the frames. ID and Macro (Using Macrosetting and 30 cm marker)
Note Frame No. in Logbook.

Editing Iol table with form F1: Record 5 of 5 Edit ▲=▼

Centre Code:	Endo:No	PRE-OPERATIVE EXAMINATION (SACMS)	ID:	Page No:

EXAM DETAILS Date: dd.mm.yy ▸ ◂ Examiner: ▸ Enumerator: ▸ Optional: ▸

PERSONAL DETAILS

Name: ▸ Age: ▸ Male: ▸ Female: ▸

Eth. Origin: ▸

Relation: ▸

Village: ▸

Admin. Unit: ▸

District: ▸ Occ.: ▸

Editing Iol table with form F1: Record 5 of 5 Edit ▲==

VISION

	R	L
Can see 6/60:	▸ ◂	▸
Cannot see 6/60:	▸	▸
Cannot see 3/60:	▸	▸
Cannot see 1/60:	▸	▸
PL:	▸	▸

CORRECTION

	R	L
Sphere (D):	▸	▸
Pinhole:	▸	▸

I.O.P.

	R	L
IOP (mm-Hg):	▸	▸

CORNEAL DATA 2

	R	L
Refraction (D):	▸	▸
Astigmatism (D):	▸	▸
Axis (degrees):	▸ .	▸ .

AXIAL LENGTH DATA and IOL-POWER

	R	L
Axial Length (mm):	▸	▸
Anterior Chamber (mm):	▸	▸
Crystaline Lens (mm):	▸	▸
IOL Power (D):	▸	▸

diting Iol table with form F2: Record 5 of 5 Edit

Centre Code:	Date:	PRE-OP ENDOTHELIUM DATA	ID:	Page No:1

ENDOTHELIUM CELL ANALYSIS DATA

Examiner: ▸ ◂ Enu.: ▸ Date: dd.mm.yy ▸

	R	L
Total (cells):	▸	▸
Minimum Size (μ^2):	▸	▸
Maximum Size (μ^2):	▸	▸
Mean Size (μ^2):	▸	▸
S.D. (μ^2):	▸	▸
C.V. (%):	▸	▸
Dens. (cells/mm^2):	▸	▸
Hexagonality (%):	▸	▸

Optional: R ▸ L ▸

Viewing Iol_surg table with form F1: Record 1 of 2 Main =

Centre Code:1	SURGICAL PROCEDURE (SACMS)	ID:10001	Page No:1/

PRE-OP DATA
Age: Male: Female: Name:

SURGERY DETAILS
Date: (dd.mm.yy) Surgeon: Enu.: Dura.: (mins) Eye: (I/N) (R) (L)
IOL-#: White-White: (mm) IOL-Size: (mm) IOL-Power: (D)

ANAESTHESIA	IOP REDUCTION	SECTION	LENS EXTRACTIO
Retrobulbar:	Digital:	Corneal:	Cryo:
Peribulbar:	Baloon:	Corneoscl.:	Forceps:
Facial Block:	Weight:	Scleral:	Tumbling:

Viewing Iol_surg table with form F1: Record 1 of 2 Main ▲=▼

IRIDECTOMY
One:
Two or More:

SOLUTIONS
Viscoelastic:
BSS:
Lactate:
Miotic:
Other:

ABORTION OF:
Procedure:
Implantation (Lens Discard):
Implantation (Lens not Discard):

COMPLICATIONS
No Complications:
Expulsive Haemorrhage:
Iris Dialysis:
Unplanned ECCE:
Capsular Rupture:
Vitreous Loss:
IOL Induced Vitreous Loss:
Corneal Trauma:
Other: 1

OPTIONAL
A B

Editing Iol_fup table with form F1: Record 8 of 8 Edit ▲=▼

Centre:1 | Endo:No | FOLLOW-UP EXAMINATION (SACMS) | Exam No:3 | ID:10002 | Page:

SURGERY AND PRE-OP DATA
Pre-Op: [dd.mm.yy]
Age: [ ] Male: [ ] Female: [ ]
Surg.: [dd.mm.yy 11.11.91] Eye: R [NoIOL] L [ ]

Name:
Eth. Origin:
Relation:
Village:
Admin. Unit:
District:
Occupation:

FOLLOW-UP (3) EXAM DETAILS
Date: [dd.mm.yy] Examiner: [ ] Enu.: [ ] Exam Status: [ ]

Name:
Relation:
Village:
Admin. Unit:
District:
Occ.: [ ]

Editing Iol_fup table with form F1: Record 8 of 8 Edit ▲=▼

VISION - P.A.C.

	R	L
Sphere: (D)		
Can see 6/6:		
Cannot see 6/6:		
Cannot see 6/9:		
Cannot see 6/12:		
Cannot see 6/18:		
Cannot see 6/60:		
Cannot see 3/60:		
PL:		
NPL:		

VISION - B.P.C.

	R	L
Sphere: (D)	10.0	
Can see 6/6:		
Cannot see 6/6:		
Cannot see 6/9:		
Cannot see 6/12:		
Cannot see 6/18:		
Cannot see 6/60:		
Cannot see 3/60:		
PL:		
NPL:		

P.H.: R [ ] L [ ]

NPR: R [ ] L [ ]

Editing Iol_fup table with form F1: Record 9 of 9 Edit ▲=▼

CONJUNCTIVA
NOA:
Red Eye:
Other:

WOUND
NOA:
Gaping:
Tissue Prolapse:
Iris Prolapse:
Vitreous Prolapse:
Other:

CORNEA
NOA:
Opacification 1a:
Opacification 1b:
Opacification 2a:
Opacification 2b:
Decompensation:
Other:

A. CHAMBER
NOA:
Shallow:
Flat:
Cells +:
Cells ++:
Hyphema:
Hypopyon:
Membrane:
Other:

Editing Iol_fup table with form F1: Record 9 of 9 Edit ▲=▼

IMPLANT
NOA:
Luxated:
Prolapsed (WOUND):
Prolapsed (PUPIL):
Corneal Touch:
Iris Touch:
Other:

IRIS
NOA:
Anterior Synechi G1:
Anterior Synechi G2:
Posterior Synechi:
Iris Bombe:
Other:

PUPIL
NOA:
Ovalling:
Seclusio:
Occlusio:
Decentration:
Other:

Editing Iol_fup table with form F1: Record 9 of 9 Edit

CORPUS VITREUM

NOA: ▸ ◂

Cells: ▸
Hazy: ▸
Opaque: ▸
Other: ▸

FUNDUS

NOA: ▸

No Details: ▸
Retinal Detachment: ▸
Optic Atrophy: ▸
Macular Scarring or Degen.: ▸
Cystoide Macular Edema: ▸
Other: ▸

INTRAOCULAR PRESSURE

IOP (mm-Hg): R ▸ L ▸

CURRENT ACTION NEEDED

Medical: ▸ Surgery: ▸

OPTIONAL

A ▸ B ▸ C ▸

Editing Iol_fup table with form F7: Record 9 of 9 Edit

Centre:	Date:	FOLLOW-UP ENDOTHELIUM DATA	Exam No:	ID:	Page:1

ENDOTHELIUM CELL ANALYSIS DATA

Examiner: ▸ ◂ Enu.: ▸ Date: dd.mm.yy ▸

	R	L
Total (cells):	▸	▸
Minimum Size (μ^2):	▸	▸
Maximum Size (μ^2):	▸	▸
Mean Size (μ^2):	▸	▸
S.D. (μ^2):	▸	▸
C.V. (%):	▸	▸
Dens. (cells/mm^2):	▸	▸
Hexagonality (%):	▸	▸

Optional: R ▸ L ▸

Editing Iol_tret table with form F1: Record 2 of 2 Edit ▲=▼

Centre Code:	Visit No:	POST-OPERATIVE TREATMENT (SACMS)	ID:	Page:

PRE-OP AND SURGERY DATA

PreOp: [dd.mm.yy] Age: [ ] Male: [ ] Female: [ ]

Surg.: [dd.mm.yy] Eye: [R] [L]

Name: [ ]
Eth. Origin: [ ]
Relation: [ ]
Village: [ ]
Admin. Unit: [ ]
District: [ ]

TREATMENT DETAILS Date: [dd.mm.yy] Examiner: [ ] Enumerator: [ ] Location: [ ]

Outpatient: [ ]
Inpatient: [ ]
Days in Hospital: [ ]
Traditional Healer Treat: [ ]
Traditional Healer Refer: [ ]

TRAVEL Bullock: [ ] Bus: [ ] Car: [ ] Foot: [ ] Other: [ ] Days Travel: [ ]

Editing Iol_tret table with form F1: Record 2 of 2 Edit ▲=

MEDICAL TREATMENT

	Local	Systemic
Steroids:	▸ ◂	▸
Antibiotics:	▸	▸
Miotic:	▸	
Mydriatic:	▸	
Other:	▸	▸

Treatment Length: [days ▸]

OPTIONAL [A ▸] [B ▸]

SURGICAL PROCEDURE 2

Simple Wound Closure: [ ]
Wound Closure with Iris Reposition: [ ]
Filtring Operation (Trabeculectomy): [ ]
AC Reformation (Flat Chamber): [ ]
IOL Reposition: [ ]
IOL Explantation: [ ]
Peripheral Iridectomy: [ ]
Optical Iridectomy: [ ]
Other: [ ]

ISM SKRIFTSERIE - FØR UTGITT:

1. Bidrag til belysning av medisinske og sosiale forhold i Finnmark fylke, med særlig vekt på forholdene blant finskættede i Sør-Varanger kommune.
   Av Anders Forsdahl, 1976. (nytt opplag 1990)

2. Sunnhetstilstanden, hygieniske og sosiale forhold i Sør-Varanger kommune 1869-1975 belyst ved medisinal-beretningene.
   Av Anders Forsdahl, 1977.

3. Hjerte-karundersøkelsen i Finnmark - et eksempel på en populasjonsundersøkelse rettet mot cardiovasculære sykdommer. Beskrivelse og analyse av etterundersøkelsesgruppen.
   Av Jan-Ivar Kvamme og Trond Haider, 1979.

4. The Tromsø Heart Study: Population studies of coronary risk factors with special emphasis on high density lipoprotein and the family occurrence of myocardial infarction.
   Av Olav Helge Førde og Dag Steinar Thelle, 1979.

5. Reformer i distriktshelsetjenesten III: Hypertensjon i distriktshelsetjenesten.
   Av Jan-Ivar Kvamme, 1980.

6. Til professor Knut Westlund på hans 60-års dag, 1983.

7.* Blodtrykksovervåkning og blodtrykksmåling.
   Av Jan-Ivar Kvamme, Bernt Nesje og Anders Forsdahl, 1983.

8.* Merkesteiner i norsk medisin reist av allmennpraktikere - og enkelte utdrag av medisinalberetninger av kulturhistorisk verdi.
   Av Anders Forsdahl, 1984.

9. "Balsfjordsystemet." EDB-basert journal, arkiv og statistikksystem for primærhelsetjenesten.
   Av Toralf Hasvold, 1984.

10. Tvunget psykisk helsevern i Norge. Rettsikkerheten ved slikt helsevern med særlig vurdering av kontrollkommisjonsordningen.
    Av Georg Høyer, 1986.

11. The use of self-administered questionnaires about food habits. Relationships with risk factors for coronary heart disease and associations between coffee drinking and mortality and cancer incidence.
    Av Bjarne Koster Jacobsen, 1988.

12.* Helse og ulikhet. Vi trenger et handlingsprogram for Finnmark.
    Av Anders Forsdahl, Atle Svendal, Aslak Syse og Dag Thelle, 1989.

13. Health education and self-care in dentistry - surveys and interventions.
Av Anne Johanne Søgaard, 1989.

14. Helsekontroller i praksis. Erfaringer fra prosjektet helsekontroller i Troms 1983-1985.
Av Harald Siem og Arild Johansen, 1989.

15. Til Anders Forsdahls 60-års dag, 1990.

16. Diagnosis of cancer in general practice. A study of delay problems and warning signals of cancer, with implications for public cancer information and for cancer diagnostic strategies in general practice.
Av Knut Holtedahl, 1991.

17. The Tromsø Survey. The family intervention study. Feasibility of using a family approach to intervention on coronary heart disease. The effect of lifestyle intervention of coronary risk factors.
Av Synnøve Fønnebø Knutsen, 1991.

18. Helhetsforståelse og kommunikasjon. Filosofi for klinikere.
Av Åge Wifstad, 1991.

19. Factors affecting self-evaluated general health status - and the use of professional health care services.
Av Knut Fylkesnes, 1991.

20. Serum gamma-glutamyltransferase: Population determinants and diagnostic characteristics in relation to intervention on risk drinkers.
Av Odd Nilssen, 1992.

21. The Healthy Faith. Pregnancy outcome, risk of disease, cancer morbidity and mortality in Norwegian Seventh-Day-Adventists.
Av Vinjar Fønnebø, 1992.

22. Aspects of breast and cervical cancer screening.
Av Inger Torhild Gram, 1992.

23. Population studies on dyspepsia and peptic ulcer disease: Occurrence, aetiology, and diagnosis. From The Tromsø Heart Study and The Sørreisa Gastrointestinal Disorder Studie.
Av Roar Johnsen, 1992.

24. Diagnosis of pneumonia in adults in general practice.
Av Hasse Melbye, 1992.

25. Relationship between hemodynamics and blood lipids in population surveys, and effects of n-3 fatty acids.
Av Kaare Bønaa, 1992.

26. Risk factors for, and 13-year mortality from cardiovascular disease by socioeconomic status. A study of 44690 men and 17540 women, ages 40-49.
Av Hanne Thürmer, 1993.

27. Utdrag av medisinalberetninger fra Sulitjelma 1891-1990.
Av Anders Forsdahl, 1993.

28. Helse, livsstil og levekår i Finnmark. Resultater fra Hjerte-karundersøkelsen i 1987-88. Finnmark III.
Av Knut Westlund og Anne Johanne Søgaard, 1993.

29. Patterns and predictors of drug use.
A pharmacoepidemiologic study, linking the analgesic drug prescriptions to a population health survey in Tromsø, Norway.
Av Anne Elise Eggen, 1994.

30. ECG in health and disease. ECG findings in relation to CHD risk factors, constitutional variables and 16-year mortality in 2990 asymptomatic Oslo men aged 40-49 years in 1972.
Av Per G. Lund-Larsen, 1994.

31. Arrhythmia, electrocardiographic signs, and physical activity in relation to coronary heart risk factors and disease. The Tromsø Study.
Av Maja-Lisa Løchen, 1995.

32. The Military service: mental distress and changes in health behaviours among Norwegian army conscript.
Av Edvin Schei, 1995.

33. The Harstad injury prevention study: Hospital-based injury recording and community-based intervention.
Av Børge Ytterstad, 1995.

34.* Vilkår for begrepsdannelse og praksis i psykiatri. En filosofisk undersøkelse.
Av Åge Wifstad, 1996. (utgitt Tano Aschehoug forlag 1997)

35. Dialog og refleksjon. Festskrift til professor Tom Andersen på hans 60-års dag, 1996.

36. Factors affecting doctors´ decision making.
Av Ivar Sønbø Kristiansen, 1996.

37. The Sørreisa gastrointestinal disorder study. Dyspepsia, peptic ulcer and endoscopic findings in a population.
Av Bjørn Bernersen, 1996.

38. Headache and neck or shoulder pain. An analysis of musculoskeletal problems in three comprehensive population studies in Northern Norway.
Av Toralf Hasvold, 1996.

39. Senfølger av kjernefysiske prøvespreninger på øygruppen Novaya Semlya i perioden 1955 til 1962. Rapport etter programmet "Liv". Arkangelsk 1994.
Av A.V. Tkatchev, L.K. Dobrodeeva, A.I. Isaev, T.S. Podjakova, 1996.

40. Helse og livskvalitet på 78 grader nord. Rapport fra en befolkningsstudie på Svalbard høsten 1988.
Av Helge Schirmer, Georg Høyer, Odd Nilssen, Tormod Brenn og Siri Steine, 1997.

41. Physical activity and risk of cancer. A population based cohort study including prostate, testicular, colorectal, lung and breast cancer.
Av Inger Thune, 1997.

42. The Norwegian - Russian Health Study 1994/95. A cross-sectional study of pollution and health in the border area.
Av Tone Smith-Sivertsen, Valeri Tchachtchine, Eiliv Lund, Tor Norseth, Vladimir Bykov, 1997.

43. Use of alternative medicine by Norwegian cancer patients
Av Terje Risberg, 1998.

44. Incidence of and risk factors for myocardial infarction, stroke, and diabetes mellitus in allmenn general population. The Finnmark Study 1974-1989.
Av Inger Njølstad, 1998.

45. General practitioner hospitals: Use and usefulness. A study from Finnmark County in North Norway.
Av Ivar Aaraas, 1998.

45B Sykestuer i Finnmark. En studie av bruk og nytteverdi.
Av Ivar Aaraas, 1998.

46. No går det på helsa laus. Helse, sykdom og risiko for sykdom i to nord-norske kystsamfunn.
Av Jorid Andersen, 1998.

47. The Tromsø Study: Risk factors for non-vertebral fractures in a middle-aged population.
Av Ragnar Martin Joakimsen, 1999.

48. The potential for reducing inappropriate hospital admissions: A study of health benefits and costs in a department of internal medicine.
Av Bjørn Odvar Eriksen, 1999.

49. Echocardiographic screening in a general population. Normal distribution of echocardiographic measurements and their relation to cardiovascular risk factors and disease. The Tromsø Study.
Av Henrik Schirmer, 2000.

50. Environmental and occupational exposure, life-style factors and pregnancy outcome in artic and subartic populations of Norway and Russia.
Av Jon Øyvind Odland, 2000.

50B Окружающая и профессиональная экспозиция, факторы стиля жизни и исход беременности у населения арктической и субарктической частей Норвегии и России
Юн Ойвин Удлан 2000

51. A population based study on coronary heart disease in families. The Finnmark Study 1974-1989.
Av Tormod Brenn, 2000.

52. Ultrasound assessed carotid atherosclerosis in a general population. The Tromsø Study.
Av Oddmund Joakimsen, 2000.

53. Risk factors for carotid intima-media thickness in a general population. The Tromsø Study 1979-1994.
Av Eva Stensland-Bugge, 2000.

De som er merket med * har vi dessverre ikke flere eksemplar av.