Small Incision Cataract Surgery (SICS)
vs.
Phacoemulsification (Phaco)

A Review
2012

National Cataract Coalition (NCC)
African Vision Research Institute (AVRI)

CONTENTS OF REPORT

A. BACKGROUND

Introduction

An estimated 670 million people, [1, 2] worldwide, are visually impaired - 39 million of which, are blind and 269 million have low vision.[3] Cataract, one of the most common eye diseases[4] and leading cause of blindness worldwide, [5] accounts for 50% of the global burden of blindness, representing more than 20 million people worldwide[6]. Subsequently cataract presents a significant public health challenge and is responsible for a visual acuity of 6/60 or worse in more than 100 million eyes.[7]

In most developing countries, blindness is associated with considerable economic and social implications which impacts on the current difficulties of vulnerable populations who reside in under-served areas.[8] An estimated 90% of people who are affected with cataracts reside in developing countries, which have limited capacity, infrastructure and technology to care for the visually impaired.[7] Moreover, these areas have limited eye care capabilities to cope with the high demand for cataract surgery. Thus, these countries exhibit the largest backlog of cataract surgeries, most of which are intumescent, mature and hyper-mature lenses (white cataracts).[9]

Cataracts are treatable[7] through cataract surgery, the most common procedure performed in ophthalmology[9] and supplemented with a pair of spectacles.[10] Near normal vision can be restored through the surgical removal of the opacified lens,[11] facilitated by the implantation of an intraocular lens (IOL).[12] To overcome the burden of cataract blindness, there must be sufficient surgical coverage and good surgical outcomes[7] viz. safety, early visual rehabilitation and postoperative emmetropia.[12] In the 20th century Intracapsular Cataract Extraction (ICCE) was the main form of lens removal but this technique had numerous disadvantages when the patient used aphakic spectacles for optical correction, such as image magnification, restricted visual fields, poor co-ordination and physical discomfort. The method that was preferred in the 1980s was extracapsular cataract extraction ECCE.[7] Phacoemulsification (Phaco) has emerged, in recent years, as the most popular procedure to treat cataracts in patients in the developing world.[9, 13] The reasons for this popularity is that Phaco is safe[12] and gives better visual

outcomes,[7] such as early visual rehabilitation and emmetropia. However, several studies have shown that despite Phaco surgery being popular in developing countries, [9, 13] it is not suitable for developing countries that have a significant backlog of patients requiring surgery, as the technique is associated with high costs, including the cost of the Phaco machine, maintenance and upgrades of the machine and facilities, staff wages and the cost of consumables. Therefore the Phaco technique is often unaffordable to disadvantages individuals and communities.[14, 15, 16, 17]

Driven by the need for more cost effective options, an increasing trend in developing countries is the use of manual sutureless Small Incision Cataract Surgery (SICS), which some have claimed is comparable to Phaco in terms of obtaining excellent visual outcomes, is faster, less costly and has fewer complications.[7] Furthermore, the higher cost of the Phaco machine and the disposable items needed for its functioning and its demand for more advanced surgical training, have to some degree, limited the use of this technique in most developing countries.[9] It is therefore critical that SICS be evaluated as an alternative for developing countries such as in South Africa, and other African countries.

The present report evaluates these two techniques, Phaco and SICS using case studies in developed and developing countries and position papers to inform the option of SICS for South Africa and other African countries. It has to be noted that this is a review of the current literature and a separate research is being conducted to determine the opinions of key stakeholders which will reflect on the practical advantages and disadvantages of SICS vs. Phaco.

Purpose of the Report

To conduct a review of the effectiveness and adverse events associated with the surgical treatment of cataracts; focusing specifically on SICS and Phaco as treatment options. To make recommendations on the most suitable treatment option for intumescent, mature and hyper-mature lenses (white cataracts) in developing countries such as South Africa.

Methodology

A systematic search of relevant articles, reports, and other published information was executed in order to develop an internal database for the investigators appraisal. The information required for the review was collected via the following search engines: PubMed, Science Direct, Hinari, and Google scholar. Research publications that were sourced emphasized on peer-reviewed empirical studies on cataract surgical techniques. Keywords that were used to source all necessary information included *cataracts, phacoemulsification, small incision cataract incision, costs, training, time and barriers to cataract surgery.* All articles and reports were considered for review if they had relevance to the subject. The search generated 50 information sources (articles, reports, documents, website information and power-point presentations. The abstract of each published source was reviewed and full text articles that focused on issues that were relevant to cataract and surgical techniques (SICS and Phaco) were downloaded. Full text articles were reviewed and additional information was sourced from the references that appeared in the full text articles. The following types of literature were sourced: meta-analysis, randomised controlled trials, prospective studies, case series, reviews, non-scientific papers and scientific articles and publications - More credibility was given to scientific articles and publication sources.

Data Extraction and Synthesis

All information relating to the study design, procedure, population and outcomes were extracted from the information sources cited in the methodology. Data synthesis included an assessment of studies and positional papers that have presented comparisons between SICS and Phaco. The recommendations emanating from these studies were considered.

B. DEFINITIONS OF CATARACT SURGERY AND TECHNIQUES

Cataract Surgery

Intracapsular and extracapsular are generic terms for cataract extraction. The former involves removing the whole lens - still within its intact capsule.[18] The technique is rarely used in developed countries except in certain circumstances when complications develop during surgery. With extracapsular extraction, the lens is removed from its capsule, which is retained within the eye. The capsule acts as a barrier between the anterior and posterior segments and is the usual site for the lens implantation.[18]

Phacoemulsification (Phaco)

The phacoemulsification procedure was first performed on the human eye by Charles Kelman in 1967.[19] This was the beginning of Phaco to address problems associated with healing, inflammation, suture related problems and astigmatism.[19] Phaco is a technique employed for the removal of cataracts using machine and micro-surgical instruments.[20] The Phaco technique usually involves making a temporal 3.0 mm scleral tunnel incision and a separate clear corneal stab for the second instrument. A trypan blue-assisted, continuous curvilinear capsulorhexis is then created followed by hydro-dissection just below the anterior capsule rim.[21] Phaco is usually performed using a phacoemulsification system in combination with a phaco-chop method.[21] The tip of the instrument is introduced into the eye through the incision. The tip generates localized, high frequency waves that break up the cataract in small fragments/ pieces. These fragments/pieces are sucked out through the tip. After cleaning the opaque cataract, a thin shell is left behind [20, 21] and the capsular bag is filled with hydroxypropy.[21] This procedure is followed by a lens implant into the capsular bag.[20, 21] The lens could be either folded or non-foldable**.** If a folded lens is implanted, the 3 mm incision that was made does not need to be enlarged and a stitch is not required because the wound is self-sealing and watertight. However, the incision must be enlarged to 5.0 to 5.5 mm, when a fixed lens is inserted and a stitch is required.[20]

Small Incision Cataract Surgery (SICS)

SICS was developed in the United States and Israel and made popular in India, with the large proportion of surgeries undertaken.[22] In this technique, extracapsular extraction is performed. The nucleus is prolapsed[22] and removed through a 6 mm scleral tunnel and aspirates the remaining cortex.[20] Venkatesh *et al.* (2010)[9] report that a 6.5-7.0 mm superior frown-shaped sclero-corneal tunnel was constructed. Thereafter, a trypan blue-assisted capsulorhexis is created and the nucleus is prolapsed from the capsular bag with a Sinskey hook or by hydrodissection injection, followed by extraction using an irrigating vectis. A single-piece rigid IOL (poly methyl methacrylate) with a 6.0 mm optic is then implanted in the capsular bag and the anterior chamber pressurized.[9] The tunnel is self-sealing and the wound does not need sutures in most cases.[9]

C. RESULTS OF STUDIES: SICS vs. PHACO

Summary of Studies Considered for this Review

- **Zia *et al.* (2010)[23]** conducted a comparison of SICS with ECCE on 100 cataract patients. ECCE was conducted on 50 patients and SICS was conducted on the remaining 50 patients. Visual acuity was recorded on the 1st postoperative day and at the 1st and 6th week after the surgery. There was significant difference in the number of patients (43.33% - 39 patients) with vision of 6/18 or better who underwent SICS with PC IOL (recorded in 6th week follow-up) as compared to number of patients (35.16% - 32 patients) who underwent ECCE with PC IOL. No significant difference was noted between the number of patients 76 (84.44%) who had full corrected postoperative vision of 6/18 or better after SICS PC IOL as compared to the 76 patients (83.51%) who underwent ECCE with PC IOL at six week follow up. The results of the study revealed that SICS and ECCE are both safe and effective techniques for the treatment of cataract and despite the requirements of instruction for ECCE and SICS being the same, the SICS procedure gives better uncorrected vision.

- **Minassian *et al.* (2001)**[24] conducted a randomized trial on extracapsular cataract extraction (232 patients with age related cataracts) and Phaco (244 patients). They found that surgical complications and capsule opacity within 1 year after surgery were significantly less in Phaco; and higher proportion of the Phaco group achieved unaided VA 6/9 or better. Phaco was noted as the cheaper option.

- **Thomas *et al.* (2003)**[25] conducted a retrospective study which compared results of filtration combined with either phacoemulsification or the Blumenthal technique of MSICS in 150 patients: 78 eyes (70 patients) that underwent phaco-triple were compared with 86 eyes (80 patients) that underwent Blumenthal MSICS. Outcome measures were intraocular pressure (IOP) reduction and achievement of target IOP - evaluated for 6 months. At 6 months, target IOP was achieved in 75.6% of the Phaco group and 73% of the Blumenthal group. Both groups showed no significant difference in IOP reduction or achievement of target IOP.

- **George *et al.* (2005)**[26] compared surgically induced astigmatism and endothelial loss following conventional ECCE, SICS and phacoemulsification with non-foldable intraocular lens implant in 186 eyes with nuclear sclerosis of grade 3 or less. Mean endothelial cell loss was similar in all the three groups (P = 0.855); ECCE induced a loss of 4.72% (SD: 13.07); SICS 4.21% (SD: 10.29) and Phaco 5.41% (SD: 10.99). Mean surgically induced astigmatism was 1.77D (1.61D) in the ECCE group, 1.17D (0.95D) in the SICS group and 0.77D (0.65D) in the Phaco group (P = 0.001). SICS caused an intermediate amount of astigmatism as compared to ECCE and Phacoemulsification. Less astigmatism was induced by Phacoemulsification than SICS and ECCE.

- **Venkatesh *et al.* (2005)**[27] cite the lower rate of infectious endophthalmitis after Phaco than MSICS. They admit, however, that the study of 42 000 consecutive cataract surgeries conducted at their institution was not a prospective randomized comparison and could have been influenced by selection bias of more affluent

patients for surgery by experienced surgeons. However, in their study comparing Phaco and SICS for white cataracts, they found that the Uncorrected Distance Visual Acuity (UDVA) was comparable on the first postoperative day and the SICS group had less corneal edema than the Phaco group. At 6 and 12 weeks the UDVA and Corrected Distance Visual Acuity (CDVA) was 20/60 for almost an equal number of patients. The mean time for surgery was shorter for SICS than for Phaco with both having excellent visual outcome and low complications rates. In their final assessment they conclude that "because manual SICS is significantly faster, less expensive, and less technology-dependent than phacoemulsification, it may be a more appropriate technique in eyes with mature cataract in the developing world".

- **Gogate *et al.* (2005)**[28] compared the efficacy, safety, and astigmatic change after cataract surgery by phacoemulsification and MSICS via a randomized control trial. The authors found that at week 1, there were 68.2% patients in the phacoemulsification group and 61.25% patients in the SICS group that had UCVA better than or equal to 6/18. At 6 weeks follow up, 81.08% patients in the phacoemulsification group and 71.1% patients in the SICS group had UCVA of better than or equal to 6/18. Gogate et al (2005) concluded that both phacoemulsification and SICS are safe and effective for visual rehabilitation of cataract patients. They also concluded that phacoemulsification gives better UCVA in a larger proportion of patients at 6 weeks.

- **Parmar *et al*. (2006)**[29] compared the pre-operative contamination of the anterior chamber among 150 eyes undergoing MSICS and phacoemulsification during a prospective, randomized, interventional clinical trial. The MSICS and Phaco group consisted of 75 eyes each and aqueous samples were taken before and at the end of surgery. Microbiological analysis was performed on collected material. Povidone-iodine 5% drops were instilled before surgery although preoperative antibiotics were not used. The authors found that the incidence of anterior chamber contamination in

the MSICS group (4%) did not differ significantly from the Phaco group (2.7%) and that the incidence of anterior chamber contamination was similar among eyes that underwent MSICS and Phacoemulsification.

- **Reddy *et al.* (2007)[30]** compared astigmatism induced by superior and temporal incisions in manual SICS and astigmatism induced by clear corneal incision versus scleral tunnel in phacoemulsification surgery. The study comprised of a total of 64 eyes (64 patients: 34 males, 30 females) that was divided into two groups: Manuals SICS and phacoemulsification. The authors found a significant against the rule shift in astigmatism in the Phaco group. The manual SICS group with temporal incision had with-the-rule shift in astigmatism. At 90 days, conventional SICS superior incisions showed 1.92 ± 0.53 D of against the rule astigmatism and temporal incisions showed 1.57 ± 0.24 D of with the rule astigmatism. Phacoemulsification with clear corneal incisions and scleral pocket showed 1.08 ± 0.36 D and 1.23 ± 0.71 D of astigmatism respectively.

- **Jha *et al.* (2006)[19]** conducted a prospective study on 69 cases of cataract for manual incision cataract surgery and intra ocular lens (IOL) implantation using 6mm straight incision and compared the surgical technique and postoperative results with the results of phacoemulsification and IOL implantation as reported in literature. Visual acuity and intraocular pressures were recorded in all cases. The results from this study showed that the average postoperative astigmatism was ± 0.75 diopters and a postoperative uncorrected visual acuity (UCVA) of 6/18 or better was observed in 51(71.9%) cases after 1st week of the surgery. The authors conclude that both phacoemulsification and small incision cataract surgery with intraocular lens (IOL) implantation are successful surgical techniques, however in the absence of Phaco equipment (the Phaco machine), SICS is an effective technique.

- **Ruit *et al.* (2007)**[16] conducted a study in Nepal on the efficacy and greater affordability of SICS versus Phaco in which a prospective randomized clinical trial of Phaco and manual sutureless SICS on 108 eyes was used to show that after 6 months, 89% of the SICS patients had UCVA of 20/60 or better and 98% had a BCVA of 20/60 or better versus 85% of patients with UCVA of 20/60 or better and 98% of patients with BCVA of 20/60 or better at six months in the Phaco group. Most importantly, these authors stressed that SICS is faster, cheaper and less technology dependent, and may be the most appropriate method for advanced cataracts for low income or developing countries. The study showed that both phacoemulsification and manual SICS achieved comparable, excellent visual outcomes.

- **Tabin *et al.* (2008)**[7] reviewed the published literature on the prevalence of cataract blindness, cataract surgery coverage and the reviews on the different surgery techniques used in the developing world. The authors concluded that both SICS and Phaco achieve excellent visual outcomes however, MSICS may be the preferred technique for cataract surgery in the developing world because surgery is faster, more affordable and is less technology dependent.

- **Sitompul *et al.* (2008)**[31] in their prospective observational study conducted in 30 subjects that underwent manual SICS or phacoemulsification, described corneal sensitivity changes caused by different incision methods in MSICS and phacoemulsification and their influence on tear film quantity and quality. Corneal sensitivity was assessed before and after surgery by Cochet-Bonnet esthesiometer. Tear meniscus, noninvasive breakup time, lipid pattern, and Schirmer test results were also evaluated. The Ocular Surface Disease Index was used to review the patient's symptoms. Corneal sensation, in the group that underwent phacoemulsification, was found to be decreased at the incision site and at other sites on days 1, 7, and 15 after surgery. However, no change in corneal sensation was

noticed in the group that underwent MSICS. No change was recorded for tear meniscus and tear lipid profile in both groups.

- **Gogate *et al.* (2007)[14]** compared the cost of phacoemulsification with foldable lens with that of MSICS in a hospital setting. The average cost of a phacoemulsification surgery for the hospital was USD 42.10, and the average cost of a SICS surgery was USD15.34, of which USD10.65 was the fixed-facility cost common to both. They found that MSICS is far more economical than phacoemulsification (see section on Costs).

- **Singh *et al.* (2009)[32]** compared the safety and efficacy of phacoemulsification versus SICS for cataract surgery in immature cataract. The study method used was a prospective randomized controlled trial which involved Phaco surgery on 93 patients and SICS on 89 patients. The study findings indicated that there were no significant differences between the groups in terms of gender, age and pre-operative visual acuity. On first postoperative day, more than two thirds of the patients from the Phaco group and more than three quarters of the patients from the SICS groups had good visual outcome. Poor visual outcome was noted for 6% of Phaco patients and 1% of SICS patients. Mean visual acuity was 0.43 ± 0.27 in phacoemulsification group and 0.47 ± 0.24 in SICS group. The SICS group recorded a shorter mean surgery time. Singh et al, therefore concluded that performing SICS was significantly faster and SICS is a suitable surgical technique to treat immature cataract in developing countries with implantation of rigid PMMA lens.

- **Kulkarni *et al*. 2010[33]** conducted a randomized prospective clinical trial in 200 cataract patients to compare safety, efficacy and cost effectiveness of MSICS with Phacoemulsification in high volume cataract surgeries. Cases were randomly assigned to the MSICS group (100) and the Phaco group (100). The results indicated that MSICS has a faster surgery time (7-10 minutes) as compared to Phaco (10-20

minutes). The surgical time for Phaco changes with type of cataract. The cost of the surgery was calculated with consideration to the fact that each blade set was used for 5 cases and one bottle of irrigating fluid (500ml) was used for 2-3 cases. The Phaco machine cost was distributed over a period of five years (an average of 10 cases per day). The authors assert that the cost of surgery is reduced in a high volume setting and thus the surgical cost will be higher if lesser surgeries are done per day. Better near vision was noted in MSISC group at 40 days follow up and patients indicated that they were satisfied with quality of vision without spectacles. However, there was a complaint noted from the Phaco group about their near vision being grossly hindered. The authors conclude that both MSICS and Phaco achieve excellent visual results and minimal surgical complications, however, MSICS is faster, cheaper and less technology dependent. Therefore MSICS is a more suitable surgical technique for high volume cataract surgery loads.

- **Venkatesh *et al.* (2010)**[9] conducted a randomized prospective study to compare the safety and efficacy of phacoemulsification and manual small-incision cataract surgery (SICS in treating white cataracts in southern India. Patients with white cataract were randomly assigned to have SICS or phacoemulsification by 1 of 3 surgeons that were experienced in conducing both SICS and Phaco. The following were compared by Venkatesh et al (2010): surgical complications, operative time, uncorrected (UDVA) and corrected (CDVA) distance visual acuities, and surgically induced astigmatism. The authors state that UDVA between the SICS and Phaco group (p=.805) were comparable on the first operative day, and less corneal damage was observed in the manual SICS group (10.2%) as compared to the Phaco group which had a corneal damage in 18.7%. UDVA in the Phaco group, at 6 weeks was 20/60 or better in 99 patients (87.6%) and 96 patients (82.0%) in the manual SICS group. The CDVA was 20/60 or better in 112 (99.0%) of the Phaco group and 115 (98.2%) of the SICS group. The time taken to conduct the surgeries was recorded as being shorter in the manual SICS group (8.8 minutes) than in the Phaco group (12.2 minutes). Posterior capsule

rupture occurred in 2 eyes (1.4%) in the manual SICS group and in 3 eyes (2.2%) of the Phaco group. The study findings showed that Phaco and SICS surgery both achieved excellent visual outcomes with low complication rates, however, SICS proved to be faster, less expensive, and less technology-dependent than phacoemulsification, and therefore may be a suitable technique to treat mature cataract in the developing world.

- **Zawar and Gogate 2011**[34] recently conducted a study on the safety and efficacy of temporal manual small incision cataract surgery (SICS) in relation to visual outcome, astigmatism, and related complications. The investigators used a number 11 disposable surgical blade that cost US$ 0.05 to perform sclerocorneal tunnel, capsulotomy, and hydrodissection. Nucleus extraction was performed by the phaco-sandwich method and the posterior chamber intraocular lens implantation was done in consideration to biometric findings. Temporal MSICS were conducted on 2000 eyes. On the 1st operative day, at 2 weeks and at 6 weeks, uncorrected visual acuity was >6/18 in 1636 (81.7%) of patients, in 1652 (82.6%) patients, and in 1732 (88.6%) patients, respectively. Best-corrected visual acuity (BCVA) >6/18 was achieved in 1868 (93.4%) patients at 6 weeks, with 46 (2.3%) having BCVA <6/60. At 6 weeks, 1876 (93.8%) eyes had with-the-rule and 134 (6.2%) against-the-rule astigmatism (mean 0.7±1.25 D). Iris prolapse was noted in 3 (0.15%), wound leak in 3 (0.15%), and transient corneal edema in 136 (6.8%) eyes. Average surgery time was 6 minutes. The authors concluded that excellent outcome is achieved with minimal astigmatism and a low complication rate with number 11 disposable surgical blade and nucleus delivery by phaco-sandwich method, at a low economic cost.

- **Cook *et al*. (2011)**[35] also recently reported the findings of a study conducted on the randomized clinical trial of Phaco vs. MSICS in South Africa at the Canadian Ophthalmology Congress in Vancouver, Canada. Using an equal number of patients for the two techniques (100), they found no difference in the VA on day one.

Corrected VA (p=0.03) and uncorrected VA (p=0.02) after 8 weeks was found to be slightly better in Phaco than in MSICS. These scientists, although they acknowledge that MSICS has been recommended "as an acceptable alternative to phacoemulsification in middle and low income countries" are of the opinion that consideration should be given to "encouraging a transition to phacoemulsification" in the South African VISION 2020 programme.

Drawing on the studies mentioned above and others, the present analysis compares the advantages and disadvantages of the two surgical techniques (viz. SICS and Phaco) and evaluates their appropriateness in the developing world in terms of a ranges of indicators, namely, visual results, time and risks.

D. ADVANTAGES AND DISADVANTAGES OF SICS AND PHACOEMULSIFICATION

Advantages and Disadvantages of Phaco

The Phaco technique, with its small self-sealing incision requires no stitches in most cases. The wound is more stable with a minimum of complications.[20] With Phaco, the patient heals faster, recovers rapidly, [17] and can resume normal activities more quickly.[20] There is also fewer follow ups/check-ups visits by patients. Additionally, the cornea is less likely to become distorted with the small incision and astigmatism is minimized.[20,36] With recent developments of advanced microprocessors, the Phaco technique offers a safe and elegant disassembly and aspiration of the lens.[17]

Despite the advantages of Phaco, the technique also has some weaknesses. The Phaco equipment requires access to biomedical engineers to maintain the equipment which is another cost factor. In developing countries there may be no individual in the entire country who has the skills or knowledge that is needed to repair the equipment.[17] Phaco has another disadvantage in that eye surgeons in developed countries, especially in the US, do not learn other surgery techniques such as SICS and ECCE. This makes it difficult for residents to acquire

the skills to undertake microscopic surgery inside the eye. In areas where optimal health care is unavailable, Phaco is not a practical solution, especially when equipment has to be transported to these areas for humanitarian work.[17] Phaco requires a dependable source of electricity for the phacoemulsification machine, and this is an added disadvantage in remote rural areas of developing countries. SICS only needs a battery or small generator to power the operating microscope in comparison.[35] Furthermore, the learning curve for Phaco is high for surgeons and can be painful for patients.[36] The Phaco procedure has also been associated with nuclear drop complications, has a high risk of serious corneal damage, and is very difficult to use in the treatment of mature hard cataracts (grade IV and V).[36] The advantages and disadvantages of Phaco are highlighted in Table 1.

- ***Advantages and Disadvantages of SICS***

There are some fairly similar advantages between the SICS and phacoemulsification cataract surgery techniques (Table 1). Studies highlighted in this paper (see section on results of studies) show that the SICS procedure offers the advantages of faster rehabilitation, less astigmatism and better post-operative vision without spectacles. Furthermore, SICS offers wider applicability and can be applied in areas that have a high cataract surgical load, such as in India. The SICS procedure requires a minimum addition to the standard cataract surgery medical equipment as compared to Phaco which requires expensive instrumentation, that is often not available at all facilities. The procedure has also been shown to have a shorter learning curve and better safety as compared to Phaco. There is also a lower cost associated with SICS, which makes the procedure economical more viable than Phaco, thus demanding less capital investment.[37]

However, the SICS procedure has a few demerits. Conjunctival congestion may persist at the site of the conjunctival flap for 5-7 days and sometimes there may be mild tenderness resulting from scleral incision.[36] In addition postoperative hyphema may occur and there is a possibility that surgical induced astigmatism can be more in SICS as a result of a larger incision than Phaco.[36]

Table 1: Advantages and Disadvantages of Phaco and SICS

PHACOEMULSIFICATION (Phaco)	SMALL INCISION CATARACT SURGERY (SICS)
Advantages	***Advantages***
• Small incision size	• High quality high volume, low-cost cataract surgery
• Good rehabilitation and	• Early rehabilitation
• Good unaided visual acuity	• Shorter learning curve
• Requires no stitches in most cases	• No suture related problems
• Topical anesthesia may be sufficient for phacoemulsification in expert hands	• Shown to cost less than phacoemulsification
• Postoperative congestion is minimal after phacoemulsification	• Less postoperative follow up
• Less corneal complications - can be performed in the posterior chamber (no prolapsing of the nucleus into the anterior chamber)	• Universal applicability - can be done on all types of cataracts
• Postoperative astigmatism is comparatively less when foldable IOLs are implanted (smaller incision - 3.2 mm).	• Applicable for remote areas – Can be performed with a relatively inexpensive microscope powered by battery or small diesel generator
Disadvantages	***Disadvantages***
• Machine dependent technique	• Surgical skill and experience of the surgeon plays a significant role in the result
• High financial investment	• Conjunctival congestion persists for 5-7 days at the site of conjunctival flap
• High cost of fixed and consumable equipment	• Postoperative hyphema may be higher
• Longer surgery time	• Mild tenderness sometimes – due to scleral incision
• Cost of maintenance/failure	• Surgical induced astigmatism is more as the incision in SICS is large (about 6 mm) as compared to phacoemulsification (about 3.2 mm)
• Long learning curve	
• Higher risk of complications in brunescent hard cataracts	
• Intraoperative complications like posterior capsule rupture are more common	
• Endothelial loss in phacoemulsification depends on the density of the nucleus	
• Requires constant reliable power, good equipment maintenance, and service of spare parts	

Sources: **Gogate *et al.*; [14] Sharaf; [15] Eyeworld; [36] Bourne; [38] Muralikrishnan *et al.*; [39] Ahmed *et al*[40]**

Table 2 shows the advantages that the SICS procedure has over Phaco and ECCE.

Table 2: Advantages of SICS over Phaco and ECCE

Over ECCE	Over Phaco
• Better wound stability	• Can be done on all types of cataracts
• Less induced astigmatism	• CCC or can opener
• Greater satisfaction with early visual rehabilitation	• Can be performed in poor visibility
• Less intra operative complications like expulsive	• Easy to convert to case of complicated Phaco
• No sutures and suture related complications	
• Fewer post-operative follow up visits	

Source: Sharaf[15]

Cost-effectiveness of Phaco vs. SICS

The cost analysis of cataract surgery varies considerably with location, surgical technique, facilities and equipment and also the method used to calculate the costs. Physicians that were interviewed in the US, India and Chile by EyeNet, agreed that Phaco is an expensive surgical technique. According to Ruit *et al*., [16] performing Phaco surgery requires expensive equipment (capital cost of the Phaco machine: about £35 000[41] @ 1992 price [R406 433] at a current exchange rate of R11.6124 per £). In the Nepal study conducted by Ruit *et al*. (2007), [16] the Phaco material required for surgery was much more costly than the equipment required to conduct SICS. An AMO sovereign phacoemulsification machine with Whitestar technology (US$ 70,000) and a high-quality operating microscope (US$ 52,000) was purchased for the study. A Zeiss 1FR operative microscope that cost only US$ 9,200 was used to perform SICS.

The cost-effectiveness of Phaco comes from its ability to return patients to work and to their functioning lives more quickly than conventional surgery.[17] In developed countries with large health budgets, the Phaco technique is generally preferred, however, in developing countries, the cost of Phaco can be prohibitive due to limited health budgets and more especially when there is a backlog of untreated cataracts.[17]

The SICS technique in comparison, is more suitable for developing countries and countries in which humanitarian aid is received because the procedure is associated with little cost - for

fluid and tubing.[17] The only expensive equipment that is required for the procedure is an operating microscope. The cost of SICS can be lowered with the use of locally manufactured IOLs, viscoelastics and pharmaceuticals, as demonstrated in the Nepal study by Ruit *et al*. (2007)[16], who found that high quality PMMA lenses manufactured in Nepal or India are about one-tenth the price of those imported from the United States.

Table 3: Cost Comparison between Cataract Surgery Techniques

Country	Study	SICS	PHACO	ECCE - IOL
India	Gogate (2007)[14]	US$15.34	US$ 42.10	-
India	Muralikrishna *et al.* (2004)[39]	US$17.03	US$ 25.55	US$ 16.25
Nepal	Ruit *et al.* (2007)[16]	US$ 15	US$ 70	-

Gogate *et al*. (2007)[14] compared the costs of Phaco with foldable lenses with that of SICS. Further to this, their paper discussed the safety and efficacy of the two techniques for the rehabilitation of cataract patients, using a controlled trial. In this study, 400 patients were treated by four surgeons. Fixed facility costs (including the Phaco machine) and recurrent consumable costs and the number of procedures were considered in their calculation. Fixed facility costs was added to the consumable costs and divided by the number of procedures to give the average cost of each of the two techniques. Phaco was found to be more expensive than SICS, US$ 42 and US$15 respectively. In addition, the use of consumables only once for surgery was found to increase the costs of phacoemulsification to US$ 69.40 and US$ 38.95 for manual SICS. When the fixed facility cost of US$10 was subtracted from the total cost of each of the techniques, the resultant cost of 5$ for SICS was six times less than that of Phaco.[14,17] Gogate *et al.* (2007)[14] also report in their article that the personnel cost for Phaco will be higher than that for SICS because of increased surgeon time and higher salaries (Table 3).

Malik *et al.* (2002)[12], in their study on cataracts of varying degrees of hardness of the lens nucleus of 750 patients, also calculated the costs of Phaco and SICS. Patients were randomly assigned to three groups, A, B and C with equal proportions of 250 persons. Group A comprised of Phaco with foldable IOLs, group B, Phaco with phaco-profile non-foldable IOLs and group C,

SICS with phaco-profile non-foldable IOLs. It is clearly evident from the table that the cost of IOL implants with SICS using rigid lenses was cheaper than Phaco with or without foldable lenses (see Table 4).[12] Additionally there was no instrumentation cost with SICS surgery and even if SICS was performed with foldable lenses, the costs would have been far cheaper than Phaco surgery.

A study conducted by Henning et al (2010)[42] in Lahan, Nepal on 8955 patients who underwent Phaco surgery by either rigid intraocular lens (IOL) (8410 patients) or foldable IOL (545 patients) showed that the cost for consumables was US$ 4.28 per operation because a single-piece PMMA IOL (US$1.94) was used – the use of a foldable IOL (US$16.50) increases the cost significantly. The authors show in this study that an additional USD $4477.50 could have been saved with MSICS, which could have been used to pay for consumables for more than 1000 more cataract surgeries. Furthermore the authors conclude that the costs do not include the cost of purchasing and maintaining the Phaco machine.[14] According to Gogate (2010),[22] foldable IOLs with Phaco surgery is definitely the gold standard but such a standard should never be the requirement in developing countries.

Table 4: Cost of Different Surgical Techniques (Rs Converted to ZAR and USD)

**Cost per patient of Phaco instrumentation was calculated by the cost of the Phaco machine divided by the number of patients who underwent Phaco surgery. Cost of replaceable items such as sleeves, Phaco tips and compressed air was calculated by dividing total cost of these items by the number of patients).*

	Group A	**Group B**	**Group C**
Preoperative Medicines	R9.45 (US$ 1.26)	R9.45 (US$ 1.26)	R9.45 (US$ 1.26)
Operative Materials			
Anesthetics	R15.75 (US$ 2.1)	R15.75 (US$ 2.1)	R15.75 (US$ 2.1)
Viscoelastics and other materials	R31.50 (US$ 4.2)	R31.50 (US$ 4.2)	R31.50 (US$ 4.2)
Disposables	R63.00 (US$ 8.4)	R63.00 (US$ 8.4)	R63.00 (US$ 8.4)
Instrumentation*	R314.96 (US$ 42)	R314.96 (US$ 42)	-
Intraocular lens	R551.18 (US$ 73)	R236.22 (US$ 31)	R236.22 (US$ 31)
Total	R985.84 (US$ 131)	R670.88 (US$ 89)	R355.92 (US$ 47)

Source: Malik et al. (2002)[12]

In the South African context, it was difficult to obtain data on the preoperative cost and most of the operative cost (anesthetics, viscoelastics and other materials), disposables and instrumentation. To the author's knowledge, no studies dealing with preoperative costs and operative materials have been conducted. However, a major cost factor in both these surgical techniques was the cost of foldable and non-foldable IOLS. It is difficult to obtain the cost of lenses from suppliers. Table 5 below illustrates the cost of lenses in the Mahatma Gandhi hospital in South Africa.

Table 5: Cost of Foldable and Non-foldable IOLS in South Africa (Rand)

IOL Type	Cost	
	ZAR	USD
Foldable (state patients)	R 250 – R 550	(US$ 33 – US$ 73)
Foldable (private patients)	+/- R 2000	(+/- US$ 267)
Non-foldable (PMMA's)	R 70 – R 150 *Depends on quality*	US$ 9.3 – US$ 20

It needs to be noted that the costs of cataract surgery includes more than just the price of the operation itself; costs also include, transport to and from the facility and a lost income for the patient. According to Yorston (2005)[5], 20% of cataract surgery costs are related to consumables (IOL, blades, eye drops) whereas nearly 80% of the cost of a cataract operation is related to fixed costs which are difficult to reduce such as staff salaries, training, and facility maintenance. In consideration to the costs borne to patients, SICS is evidently the more viable solution as the advantages mentioned in table 1 clearly show the findings from studies that validate that SICS is associated with quicker surgery time, faster rehabilitation and healing and is more affordable because it is less technologically dependent.

- ***Visual Results of Phaco vs. SICS***

In the context of the debate on the two techniques, Singh *et al.* (2009)[32] noted a greater poor visual outcome for phaco (6% of patients) compared to SICS (1% of patients). Mean visual acuity was 0.43 ± 0.27 in phacoemulsification group and 0.47 ± 0.24 in SICS group. Gogate *et al*. (2007)[14] reported that visual results of Phaco and SICS surgeries was the same as uncorrected VA at six weeks had little difference. VA of 6/18 was obtained by 81.1% of Phaco patients compared to 71.1% of SICS patients. Similar uncorrected VA one day post operatively was reported by Ruit *et al*. (2007)[16] in there Nepalese study contrasting Phaco and SICS. They also found that VA at six months was also comparable (98% of both groups had UCVA and BCVA of 20/60).[16] In the Minassian *et al*. (2001)[24] study, a higher proportion of the Phaco group achieved unaided VA 6/9 or better.[24] However, Venkatesh *et al*. (2010)[9], showed that Phaco and SICS surgery both achieved excellent visual outcomes with low complication rates.

Jha *et al.* (2006)[19] in comparing the results of their study on SICS and intraocular lens implantation with results from the literature on Phaco, found that 59 (85.5%) cataract surgery cases achieved best-corrected visual acuity (BCVA) of 6/12 or better, 6 (8.7%) cases had BCVA between 6/18 and 6/24, and 4 (5.8%) cases had BCVA of 6/36 or less. After the first week of the surgery, postoperative visual acuity of 6/18 or better was observed in 51 (71.9%) of SICS. Jha *et al*. (2006)[19] also found out of the 69 surgery cases that 59 (85.5%) cases had astigmatism of 0 to 1 diopter, 4 (5.8%) cases had astigmatism that ranged from ± 1.25 to 1.75 diopters, and 6 (8.7%) cases had astigmatism of ± 2 diopters. There were 75% of the cases that showed against the rule (ATR) change and the nucleus in all cases was successfully delivered[19].

Other studies have also shown the effectiveness of SICS on visual outcomes, however these studies were not compared to a sample of patients under-going Phaco surgery but should be considered as the findings indicate that SICS has a good visual outcome. Ahmed *et al*. (2005), [40] for example, performed a study on the visual recovery of 115 patients who were operated upon using the SICS technique. The investigators performed follow-ups at 1st week, 3rd week, 6th week and 12th week after the surgery. The study findings showed that best corrected visual acuity of 6/12 or better was achieved by 95.65% of patients and the mean surgically induced astigmatism at 3 months was 0.69 Diopters. The authors conclude that patients undergoing SICS have an early visual rehabilitation as about 60.8% of patients obtained 6/12 or better vision in the first 3 weeks. Swift visual restoration can be attributed to little inflammation and less surgically induced astigmatism from SICS. Only a few complaints were reported from patients in relation to ocular discomfort (pain, foreign body sensation and redness). Guzek *et al.* (2003)[43] found in their study conducted on 200 eyes undergoing small incision manual extra capsular cataract surgery, that 90% of eyes achieved a final best corrected visual acuity of 6/12. They also noted that patients had faster visual recovery and lower incidence of ocular inflammation. Hepsen *et al*. (2000)[44] also achieved a post-operative best spectacle corrected visual acuity of 6/9 or better in 83% of eyes that underwent small incision extra capsular cataract surgery.

However, the study conducted by Henning *et al.* (2010)[45] showed that a total of 31.4% of eyes had UCVA of 6/9 or better with a foldable IOL compared with 23.1% of eyes with a rigid intraocular lens and there was no difference observed in the patients achieving 6/18 or better. The study findings indicate that 78 eyes had a poor outcome which could be due to pre-existing retinal disease in 42 eyes, surgical complications in 34 eyes, and refractive error in two eyes. In addition 4 eyes had a poor outcome with foldable IOLs resulting from co-morbidity in two eyes, and surgical complications in two eyes.[45] *For more findings: (see section on results of meta-analysis).*

- ***Surgery Time: Phaco vs. SICS***

In the Gogate *et al*. (2007)[14] study, the average time for Phaco and SICS was 15 minutes: 30 seconds and 8 minutes: 35 seconds, respectively. There is a significant difference of about 7 minutes between the two techniques and thus the SICS procedure takes less time to complete.[22] Ruit *et al*. (2007)[16] also report the shorter surgical time for SICS which was 9 minutes as compared to 15 minutes: 30 seconds for Phaco. Venkatesh *et al*. (2005) show an average time for SICS of 3.75 minutes per case or 16-18 cases per hour. The study conducted by Singh *et al*. (2009)[32], recorded a mean surgery time of 7 minutes for Phaco surgery and 5 minutes and 18 seconds for SICS. The authors also observed a shorter in nucleus extraction time compared to phacoemulsification of nucleus, faster epinucleus removal and faster cortex aspiration by simcoe cannula compared to irrigation and aspiration cannula resulted in faster surgery by the SICS method. In a randomized prospective study Venkatesh *et al*. (2010) report that the mean time was shorter in the SICS group (8.8 minutes) compared to Phaco (12.2 minutes).[9] An earlier study by Prajna *et al.* (1998)[46] reported similar results - manual SICS surgical rate of 12–16 cases per hour.

In countries where there is a backlog of cataract patients, specifically developing countries, the concept of "time" is extremely important as more patients can be attended to if shorter time is taken for surgery. The training of surgeons for Phaco requires a longer training period, whereas those trained to undertake ECCE surgery find it easier to learn SICS[7]. According to Malik *et al.*

(2002), [12] Phaco has a steep learning curve which will account for increased costs. In developing countries where there are few ophthalmologists, SICS will therefore be a much better option.[14]

Risk and Complications

Compared to Phaco, there is more risk of astigmatism with SICS.[17] According to Gogate (2010)[22], the difference is minimal (0.3-0.5) between the two techniques. This situation arises when the construction of the wound is improperly done.[17] On the first operative day, there is also more risk of corneal edema.[17] Ruit *et al*. (2007)[16] reported, in their study, that there is more risk of getting posterior capsular opacification amongst the SICS group than the Phaco group. Another common risk with the SICS technique is iris injury.[17]

Cataract Surgery Training

It is essential that specially trained surgeons and support staff are used to conduct cataract surgery via the Phaco technique. As mentioned previously, the learning curve for Phaco is steep[22] and it may be much easier to learn SICS.[7] The SICS technique is similar to ECCE and many eye surgeons in developing countries are trained in this techniques.[7] Astbury (2009)[47] noted that most surgeons in developing countries are skilled in ECCE and could benefit from additional training to convert to SICS, despite the barriers to learning the SICS procedure (Ravindran *et al*. (2009) (table 6).[49] The learning curve would thus be smoother and it would be less costly because of the shorter time in training. Moreover, according to Gogate *et al*. (2003: 55)[37] "the change to MSICS is easier than learning phacoemulsification, as anterior chamber dynamics in MSICS are similar to conventional ECCE."

Table 6: Barriers to Converting to SICS and Stages of Difficulty

Barriers	Difficult Stages
• Insufficient training programmes	• Tunnel construction
• Refusal of surgeons to change from Phaco or ECCE to SICS	• Prolapsing the nucleus into the anterior chamber
• Increased complexity for surgeons who have not mastered ECCE	• Capsulotomy (or capsulorhexis)
	• Nucleus extraction
	• Cortex removal from under the incision

Source: Ravindran et al, cited in (2009)

SICS can be performed using different techniques. These should be taught in a training center in a stepwise fashion under supervision.[48] There are many demands when learning sutureless cataract surgery and it should be taught formally.[50] Surgeons should have consistently good, self-evaluated results with conventional cataract extraction before starting sutureless surgery.[49] According to Ruit *et al*. (2007)[16], "The extensive surgical training that is required for phacoemulsification is unrealistic in health care systems with severe shortages of ophthalmologists." Phaco surgeons, with their more sophisticated technique, are inappropriate for solving the global cataract problem, [48] especially in developing countries in Africa. Once the SICS technique has been mastered by non-phaco surgeons, they can play a significant role in reducing cataract blindness[42] in developing countries.

In order to validate the suggestions made below for the South African situation a purposeful survey was undertaken amongst leading South African authorities and eye care specialists, the results of which will be presented separately due to delays in securing the data and interviews.

E. CONCLUSION AND RECOMMENDATIONS

In the South African context, there are few published studies reporting the outcome of Phaco vs. SICS or conventional ECCE.

In developing countries with limited health resources and large populations, such as South Africa, and other African countries, cataract extraction should comprise of the following features: cheap and affordable, early rehabilitation to avoid economic loss, near emmetropic visual status postoperatively, minimal complications, minimal wound suturing (Malik *et al*., 2002)[12], faster with increased surgical coverage[35] and safe and effective.[47]

Phaco has all the above features except an increase in surgical coverage, but all these merits are available with SICS in settings where it has been widely used. Phaco is costly with its pre- and post-operative medicines, anesthetic agents, viscoelastic materials, disposables, instrumentation and IOLs. It also has a steep learning curve[12] which is also costly[12,16] as

illustrated above. The advantage that SICS has over Phaco is that it is faster and cost-effective especially for advanced white cataracts.[22] Capital, maintenance and per-case disposable costs that are associated with Phaco are avoided with SICS.[16,22] In a developing country, the importance of surgical speed and efficiency are crucial as there is a shortage of human resources for eye surgeries (ophthalmic surgeons).[16,22] It is crucial, therefore, to institute a surgical technique that is capable of serving the majority of those disadvantaged in developing countries. In order to cut the costs associated with Phaco and increase efficiency, the alternative is SICS given the relatively similar post-surgical outcomes.

It should be noted that the above recommendations emanating from the meta-analysis are in contrast to that of Cook et al. (2011)[35]. Although these authors are aware that scleral tunnel extracapsular surgery has been recommended as an alternative in middle and low income countries, they advocate a transition to Phaco in South Africa's VISION 2020 programme. They did find that uncorrected and corrected VA to be better in Phaco and less astigmatism in Phaco treated patients at 8 weeks which may have been the basis for their conclusion. However, their study was based on a non-expertise design which may be a limitation as compared to the prospective randomized, expertise designs of the comparative studies on Phaco vs. SICS. They however draw their conclusions from their experience in cataract programs via the Christian Blind Mission's (CBM). As Cook (2011)[35] stated in his presentation: "The transition to phacoemulsification cataract surgery is a logical transition that is taking place within CBM supported programmes" where ophthalmologist are "keen to do phacoemulsification", "numbers justify added capital expense, "a proportion of eyes are suitable for phacoemulsification", "addition costs for instruments and consumables can be accommodated in the project budget and "where training of ophthalmologists could be prioritized for the transition (2011)." It should also be noted that there is a dearth of comparative academic studies of Phaco vs. SICS in South Africa and currently, heavy reliance is being placed on the Asian continent, especially India. The study by Venkatesh et al. (2005: 1083)[27] indicates clearly that high quality, high volume SICS "can be attained in a high volume setting" using

"standardized protocols, standardized training of surgeons and paramedical personnel, and an overall organizational structure that supports high volume patient flow".[27]

We can therefore conclude that based on this review, SICS seems to be the preferred technique of choice for less resourced settings. However, the fact that much of the research is based on high volume settings in Asia, the lower volumes often served in South African and African settings may influence the skills and potential for training of surgeons. It is therefore recommended that a study be conducted in South Africa to evaluate the suitability of SICS. This is critical as currently Phaco is widely used in South Africa while the literature points to SICS being the procedure of choice to cater for larger populations in developing countries with limited heath resources.

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