Manual Small Incision Cataract Surgery

Bonnie An Henderson
Editor

EXTRAS ONLINE

Springer

Manual Small Incision Cataract Surgery

Bonnie An Henderson
Editor

Manual Small Incision Cataract Surgery

Springer

Editor
Bonnie An Henderson
Ophthalmic Consultants of Boston
Waltham, MA
USA

Additional material to this book can be downloaded from http://link.springer.com/978-3-319-24664-2

ISBN 978-3-319-24664-2 ISBN 978-3-319-24666-6 (eBook)
DOI 10.1007/978-3-319-24666-6

Library of Congress Control Number: 2015960387

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Contents

Manual Small-Incision Cataract Surgery

Venkatesh Rengaraj, Steven S. Ma, and David F. Chang

Why MSICS Technique Is Performed

Cataract is the leading cause of avoidable blindness worldwide, accounting for nearly half (47.8 %) of all cases of blindness [1]. According to the World Health Organization (WHO), an estimated 20 million people worldwide are blind from bilateral cataracts [2]. While this poses one of the greatest public health challenges for developing countries, it poses a growing economic challenge for the well-developed country as well.

Tabin et al. concluded that cataract accounts for almost 75 % of blindness in the developing world [3]. It is estimated that over 90 % of the world's visually impaired live in developing countries [4]. In these communities in particular, blindness is associated with considerable disability and excess mortality, with dire economic and social consequences [5]. These statistics reveal a profound societal economic impact through the loss of productivity of both the blind and those who care for them. Because of the significant reduction in life expectancy and quality of life for the blind, sight-restoring cataract surgery is undoubtedly one of society's most cost-effective medical interventions. The increase in economic productivity during the first postoperative year alone is estimated to exceed the cost of the surgery by a factor of 15 [6].

V. Rengaraj, MD
Aravind Eye Hospital, Thavalakuppam, Pondicherry 605007, India
e-mail: venkatesh@pondy.aravind.org

S.S. Ma, MD
Fellow, Royal College of Surgeons (Canada), Adjunct Clinical Professor,
Pacific University College Optometry, Los Angeles, CA, USA
e-mail: sma.eyemd@gmail.com

D.F. Chang, MD (✉)
Department of Ophthalmology, University of California San Francisco,
762 Altos Oaks Drive, Los Altos, CA, USA
e-mail: dceye@earthlinlink.net

B.A. Henderson (ed.), *Manual Small Incision Cataract Surgery*,
DOI 10.1007/978-3-319-24666-6_1

In well-developed countries, increased life expectancy and the growing baby boomer population is contributing to higher demand for cataract surgery. The vision requirement needed to drive legally, and patients' desires for better vision to enhance quality of life, exponentially increases this demand. While in 2004, 20.5 million Americans older than age 40 were estimated to have cataract in either eye, that number is estimated to rise to 30.1 million by 2020 [7]. In the United States, more ophthalmic surgeons are needed to address this demand. Shift in ophthalmic surgical education in the 1990s from manual cataract surgery to phacoemulsification, the broad acceptance of phacoemulsification by practicing ophthalmologists, and attrition of older ophthalmologists trained in the manual techniques of cataract surgery have meant a growing reliance on phacoemulsification as the main modality for cataract surgery in the developed world [8]. Many training programs in the United States no longer train their residents in techniques other than phacoemulsification [9]. Since inception, phacoemulsification technology has evolved from a far simpler device console to today's intelligent microprocessor-controlled consoles with sophisticated fluidics and myriad of handpieces and tips. Research and development costs have been factored into the capital cost of phacoemulsification consoles and consumables needed for each procedure.

The cataract surgical rate (CSR) is an important public health metric which represents the number of cataract operations annually performed per one million population. There are significant variations in the CSR among different countries. As expected, the highest rates are seen in those countries with the highest gross domestic product (GDP). The CSR in economically well-developed countries is usually between 4000 and 6000 cataract operations per million population per year. The recent Rochester Epidemiology Project data from the United States reported a CSR of 11,000 in Minnesota as of 2011, a rate which has increased since 2005, without showing signs of leveling off [8]. India has dramatically increased its CSR in the last 20 years from less than 1500 to around 4000 currently. In the middle-income nations of Latin America and parts of Asia, the CSR ranges between 500 and 2000 per million per year. In most of Africa, China, and the poorer countries of Asia, the CSR is closer to 500 or less [10]. It is certainly surprising that China, which has experienced a tenfold rise in its GDP since 1978, has such a low CSR. This places China on par with some of the poorest African nations [6].

Naturally, it is those countries with the lowest CSR that have major problems with increasing cataract blindness. There is clearly a pressing need in the developing world to reduce the backlog of cataract blindness by increasing the CSR over current low rates. In order to prevent a country's backlog of cataract blindness from increasing, the CSR must at least equal the rate of new cases of advanced cataract each year. There are many reasons for low cataract surgical rates in developing countries. Besides obvious factors such as lack of affordable care and access to cataract surgeons, less obvious barriers to delivering needed care include ignorance, fear of surgery, cultural factors, lack of transportation, and poor visual outcomes associated with inadequately trained surgeons and poor surgical practices [10, 11].

Phacoemulsification is the accepted standard for cataract surgery in the developed world. Although it is often available in the developing world, particularly to those cataract patients who can privately afford it, there are many disadvantages to this method for the poorest societies. Compared to manual extracapsular cataract surgery (ECCE), phaco requires a significant capital purchase and higher costs per case. Annual maintenance is not only an issue of cost but also of readily available technical support. In addition, there is a longer learning curve for new cataract surgeons to master, which is particularly challenging given the poor educational infrastructure available to most ophthalmologists in the developing world. Finally, the advanced mature cataracts that are so prevalent among poor populations are more challenging to remove with phaco, and the complication rate is higher with these cataracts in the hands of all but the most skilled and experienced phaco surgeons using the most advanced phaco systems. Yet even if phacoemulsification technology were universally available in developing countries, the cost to use this technology might be prohibitive for many health-care settings.

Because of these challenges associated with phaco in the developing world, alternative cataract surgical techniques such as sutureless manual small incision cataract surgery (MSICS) are gaining popularity in these countries. MSICS is able to achieve excellent outcomes with lower cost and average surgical time than phaco. Besides speed and affordability, for less experienced surgeons, MSICS is easier to learn and safer for advanced mature cataracts. Factoring the dearth of vitreoretinal surgeons in many developing world communities, the rarity of dropped nuclei with MSICS is an important but frequently overlooked factor.

Origins of MSICS Technique

Classical Blumenthal Technique of MSICS

As phaco became more popular in the 1980s, extracapsular cataract extraction (ECCE) techniques utilizing smaller incisions were also explored and advocated. In 1987, Blumenthal first described the use of an anterior chamber maintainer (ACM) in ECCE along with a reduction in incision size [12]. The classic "Mini-Nuc" MSICS procedure as described by Blumenthal employs the ACM to allow virtually all steps to be performed under positive pressure. After placement of the ACM fixation, a side port is made and a capsulotomy is performed. The scleral tunnel incision is made and the hydrosteps are carried out. The nucleus is guided out of the eye by a glide, and this is facilitated by the positive pressure generated by the ACM. Aspiration of the cortex is carried out through a side port using an aspirating cannula, while irrigation is supplied by the ACM. The ACM is only removed after the IOL is inserted and the incision is confirmed to be watertight.

Modifications to MSICS Technique

Another major modification in the technique of MSICS was later introduced by Ruit et al. [13]. A 6.5–7-mm temporal scleral tunnel was created with a straight incision, starting 2 mm posterior to the limbus. A side port was created to facilitate further intraocular manipulation. A "V"-shaped capsulotomy and hydrodissection were performed. Viscoelastic was injected above and behind the nucleus, which was then prolapsed into the anterior chamber. An irrigating Simcoe cannula with a serrated surface was inserted below the nucleus, prior to extracting it through the scleral tunnel. The remaining cortex was manually removed with the same Simcoe irrigation-aspiration cannula. After implanting a PMMA lens into the capsular bag, the unsutured scleral pocket incision was confirmed to be watertight.

Other major modifications to the MSICS technique described in the literature relate either to the incision or nucleus delivery.

Variations in Incision

Richard Kratz was the first surgeon to move the cataract incision posteriorly from the limbus to the sclera in order to enhance wound healing and reduce astigmatism. It was Girard and Mailman [14] who coined the term of scleral tunnel incision. Singer [15] described the "frown incision" which was a modified scleral pocket incision, curved opposite to the natural limbal curve. The purpose of the frown configuration was to reduce wound-induced astigmatism. Lam et al. [16] developed the sutureless large-incision manual cataract extraction (SLIMCE) technique as a modified manual ECCE technique specifically designed to allow less experienced surgeons in developing countries to reliably extract the nucleus through a self-sealing temporal scleral pocket incision. The salient features of this modified technique include (1) a large scleral pocket incision (8-mm linear length) to permit safe and easy nucleus expression, (2) a long sclerocorneal tunnel (4 mm) for achieving a self-sealing sutureless wound, (3) a posterior incision position (2 mm posterior to the limbus) and a frown-shaped wound configuration for astigmatic neutrality, and (4) the use of an anterior chamber (AC) maintainer to assist nucleus delivery. Gokhale et al. [17] compared the induced astigmatism with various positions of scleral incision (superior, superotemporal, and temporal incision) in MSICS and found that surgically induced astigmatism was lower with the temporal and superotemporal incisions compared to incisions located superiorly.

Variations in Nucleus Delivery

Hydroexpression and viscoexpression – Corydon and Thim [18] introduced the concept of hydro- or viscoexpression of the nucleus with the help of a specially designed bent cannula to deliver the nucleus through a continuous circular capsulorhexis. Several studies have confirmed the efficacy of these procedures [19, 20].

Sandwich technique – Bayramlar et al. [21] performed MSICS in 37 eyes using their sandwich technique. After capsulorhexis, hydrodissection, and hydrodelineation, the nucleus was prolapsed into the anterior chamber and extracted by sandwiching it between the irrigating vectis and iris spatula.

Modified fish hook technique – Hennig et al. [22] reported data from 500 eyes in which MSICS was performed using the fish hook technique for nucleus delivery. This technique utilizes a sclerocorneal tunnel, capsulotomy, hydrodissection, and nucleus extraction with a needle tip bent into a sharply curved hook. The mean duration of surgery was 4 min.

Use of anterior chamber maintainer (ACM) – Blumenthal and Moisseiev [11] described the use of an anterior chamber maintainer during the surgery. Its use was found to increase intraoperative safety, which was later confirmed in other studies as well [23, 24].

Irrigating cannula – Nishi [25] described the use of an irrigating cannula for nucleus delivery. It consists of a 20-gauge needle attached with a flat insertion plate at 90° to its axis with a flow outlet. The apex of the plate, with the flow outlet, is inserted beneath the nucleus during continuous irrigation, and the nucleus is expelled by the irrigating solution.

Manual phaco fracture – Bartov et al. [26] described a technique for planned manual extracapsular cataract extraction (ECCE) incorporating a modification of mini-nuc ECCE in which the scleral tunnel is made wide enough to allow a nucleus of any size to become lodged within the tunnel. A 5.0-mm, inverted-V "Chevron" frown incision is made in which the exposed part of the nucleus lodged in the scleral pocket can be manually sliced and fragmented until it is small enough to be removed through the incision. Vector analysis of preoperative and 3-month postoperative keratometric astigmatism in 30 patients showed that the surgically induced vector was 0.54 diopter (D) ± 0.58 (SD).

Nucleus trisection – Kansas and Sax [27] described a technique in which the nucleus is manually split into three pieces using Kansas trisector and vectis, so that the resulting smaller fragments can be viscoexpressed through a small incision. Hepsen et al. [28] performed MSICS by manual phacotrisection technique in 59 eyes of 54 patients. After capsulorhexis and hydrodissection were performed, the endonucleus was prolapsed into the anterior chamber and trisected using an anteriorly positioned triangular trisector and posteriorly placed solid vectis.

Nuclear management by snare technique – Keener [29] in 1983 was the first to snare the nucleus into two halves and bring the fragments out through a sclerocorneal flap valve incision. A wire loop stainless steel snare is a single instrument with two cannulas with the wire loop in the tip of the first cannula. While pulling the second cannula, the wire loop constricts. When the wire loop is lassoed around the nucleus and constricted, it divides the hardest of nuclei into two.

Sinskey hook method – Rao and Lam [30] described an MSICS technique using two Sinskey hooks to extract the nucleus from the capsular bag. The two Sinskey hooks are introduced through separate paracentesis entry sites. The left-handed hook is slipped under the capsulorhexis where it engages, rotates, and elevates the superior pole of the nucleus toward the incision. The second hook held in the right hand is placed beneath the elevated superior pole of the nucleus to prevent it from falling back into the bag as the first hook is retracted.

Advantages/Disadvantages of MSICS

To evaluate MSICS against phacoemulsification, the following areas need to be examined: surgically induced astigmatism, intraoperative and postoperative complications, appropriateness for advanced mature cataracts, surgical times, and costs.

Surgically Induced Astigmatism

Table 1 reports data from several studies comparing surgically induced astigmatism with phacoemulsification and MSICS at 6 weeks and 6 months postoperatively. At 6 months follow-up, Ruit et al. [31] reported mean astigmatism of 0.7 D for the phacoemulsification group and 0.88 D for the MSICS group. This difference was not statistically significant. At 6 weeks postoperatively, Gogate et al. [32] reported mean astigmatism of 1.1 D for phacoemulsification and 1.2 D for MSICS which was not statistically significant. Both of these studies used a foldable IOL in the phacoemulsification arm. Both Venkatesh et al. [28] and George [33] reported that phacoemulsification caused significantly lesser surgically induced astigmatism compared to MSICS at 6 weeks postoperatively. This would explain the poorer uncorrected visual acuity levels at 6 weeks for the MSICS group. Another randomized trial [34] comparing surgically induced astigmatism associated with phacoemulsification and MSICS reported no significant difference at either the 6 weeks or 6 months follow-up exam. Muralikrishnan et al. [33] reported that, compared to the surgical induced astigmatism of approximately 4 diopters for large-incision ECCE, MSICS and phacoemulsification were clearly superior with approximately 1 diopter of induced astigmatism.

Other MSICS studies report differences in surgically induced astigmatism based on incision size made and the type of tunnel construction (Table 2). A prospective Japanese trial comparing 3.2-mm with 5.5-mm MSICS incisions found 0.3 D less surgically induced astigmatism when the smaller incision was used [35]. Additional MSICS studies report less surgically induced astigmatism with temporal and superotemporal scleral tunnel incisions compared with those located superiorly [16, 36].

Table 1 Surgically induced astigmatism of phacoemulsification and MSICS (in diopters)

	At 6 weeks		At 6 months	
Study	Phaco	MSICS	Phaco	MSICS
Venkatesh [32]	0.80	1.20	–	–
Gogate [31]	1.10	1.20	–	–
George [28]	0.77	1.17	–	–
Ruit [30]	–	–	0.70	0.88
Muralikrishnan [33]	1.10	1.12	1.11	1.33

Table 2 Surgically induced astigmatism of MSICS according to the type of tunnel constructed

Study	Superior (diopters)	Superotemporal (diopters)	Temporal (diopters)
Venkatesh [32]	1.08	–	0.72
Kimura [34]	1.41	1.02	–
Gokhale [16]	1.28	0.20	0.37
Reddy [35]	1.92	–	1.57

Common hypotheses for this observation are that temporal incisions are less likely to be affected by blinking and gravity.

Overall, early postoperative surgically induced astigmatism was either the same or slightly worse with MSICS in these various studies, but incision location appears to be an important variable. For MSICS, smaller incision size and temporal location gives astigmatic results closest to phaco. The only prospective randomized comparison with long-term (6 months) data showed no difference in surgically induced astigmatism between phaco and MSICS performed temporally [30].

Intraoperative and Postoperative Complications

Both retrospective and prospective studies have compared complication rates for phaco and MSICS. The three prospective studies comparing phaco and MSICS reported the incidence of posterior capsule rupture (PCR) with each of the two techniques (Table 3). In their study of white cataracts, Venkatesh et al. [32] reported that PCR occurred in 2.2 % of cases performed with phacoemulsification compared to 1.4 % of cases performed with MSICS; Ruit et al. [30] had a 1.85 % PCR rate with phacoemulsification compared to zero in the MSICS group. In a retrospective analysis of safety and efficacy of MSICS for brown and black cataracts, Venkatesh et al. encountered PCR in only 2 % of their cases. However, Gogate et al. [31] reported a slightly higher rate of PCR for MSICS (6 %) compared to phacoemulsification (3.5 %). It should be noted that all of the prospective trials had small study populations.

The largest and best comparative study to date was a retrospective study by Haripriya et al. [37], which analyzed 79,777 consecutive surgeries performed during a 1-year period at the Madurai Aravind Eye Hospital. Of these, 20,438 (26 %) were phaco, 53,603 (67 %) were MSICS, and 5736 (7 %) were large-incision ECCE. The overall rate of endophthalmitis was 0.04 % with no statistical difference between phaco and MSICS (Table 4). If performed by staff surgeons, both procedures had complication rates less than 1 %, suggesting comparable safety in the hands of experienced surgeons. However, for trainee surgeons (residents, fellows, and visiting surgeon fellows), the complication rate was significantly higher with phaco (4.8 %) than with MSICS (1.46 %) ($P < 0.001$). For example, the trainee rate of posterior capsule rupture with vitreous loss was 3.8 % with phaco and 0.67 % with MSICS ($P < 0.001$).

Table 3 Percentage of intraoperative and postoperative complications related to phacoemulsification and MSICS

Complications	Study	Phacoemulsification			MSICS		
Posterior capsule rupture	Venkatesh [32]	2.2			1.4		
	Gogate [31]	3.5			6.0*		
	Haripriya (staff) [37]	0.65			0.5		
	Haripriya (trainees) [37]	4.6			0.84		
	Ruit [30]	1.85			0		
PCO at 6 months	Ruit [30]	***None***	***1+***	***2+***	***None***	***1+***	***2+***
		85.4	14.6	0	56.5	26.1	17.4
Endothelial cell count	George [28]	4.21			5.41		
Anterior chamber contamination	Parmar [36]	2.7			4		
Endophthalmitis	Haripriya [37]	0.05			0.03		

Table 4 Intraoperative complication rate comparison between different surgeon groups for each of three surgical techniques [37]

Surgeon category	Total surgical volume	Intraoperative complication rate			
		Phaco	MSICS	ECCE	Overall
Staff	52,274	174 (0.9 %)	225 (0.71 %)	13 (1.03 %)	412 (0.79 %)
Fellow	11,324	15 (2.06 %)[a]	85 (0.94 %)[a]	35 (2.30 %)[a]	135 (1.19 %)[a]
Resident	14,818	10 (8.2 %)[a]	216 (1.75 %)[a]	79 (3.39 %)[a]	305 (2.06 %)[a]
Visiting trainee	1361	28 (11.2 %)[a]	18 (3.68 %)[a]	22 (3.54 %)[a]	68 (5.0 %)[a]
Overall	79,777	227 (1.11 %)	544 (1.01 %)	149 (2.60 %)	920 (1.15 %)

From Haripriya [37]

Phaco phacoemulsification, *MSICS* manual small incision cataract surgery, *ECCE* extracapsular cataract extraction

[a]Means $p < 0.05$ when compared to the staff complication rate for the respective procedure

Posterior capsule opacification (PCO) occurred more often in the MSICS group compared to the phacoemulsification group in the Ruit study [30]. In that study, at the 6-month follow-up exam, 26.1 % of the MSICS patients compared to 14.6 % of the phaco patients had grade 1 PCO. The incidence of grade 2 PCO was 17.4 % in the MSICS group and zero in the phacoemulsification group. In this study, foldable IOLs with a square edge were employed in the phaco patients, compared to a rounded edge PMMA IOL in the MSICS patients, and only the phaco patients had a capsulorhexis.

Overall, complication and endophthalmitis rates appear to be similar between both procedures when performed by experienced surgeons. However, for inexperienced surgeons, MSICS appears to be the safer procedure.

Appropriateness for Advanced Cataracts

Advanced and complicated cataracts are far more prevalent in poor populations. The literature reports good visual outcomes and complication rates when MSICS is employed for complicated cases, such as ultra-brunescent cataract [38], white cataracts [32, 39], and cataracts causing phacolytic and phacomorphic glaucoma [40, 41].

Finally, for a surgeon already experienced with manual large-incision ECCE, the learning curve for MSICS is shorter compared to that for learning phacoemulsification, which is more challenging to perform in advanced cataracts. Brunescent and mature cataracts increase the risk of posterior capsular rupture, dropped nuclei, and corneal decompensation. Therefore, an important consideration is that in many developing world settings, access to vitreoretinal or corneal transplantation surgery may be limited or completely lacking.

Surgical Times

Another consideration in the developing world is the desirability of performing very high-volume surgery. In terms of mean procedural times, MSICS takes significantly less time than phacoemulsification (Table 5), even in the hands of very experienced surgeons. In their comparative trials, Ruit et al. [30] and Gogate et al. [31] reported identical mean surgical times (including turnover) of 15.5 min for phacoemulsification and 8.5–9 min for MSICS. Others have reported reducing mean surgical times to less than 4.5 min with MSICS [42, 43]. In the developing world, where care and procedures must be scalable to the highest volumes, improved surgical efficiency increases the productivity of the most critically scarce resource – the cataract surgeon.

Table 5 Mean duration (minutes) of phacoemulsification and MSICS

Study	Phacoemulsification	MSICS
Ruit [30]	15.5	9
Gogate [31]	15.5	8.5
Trivedy [46]	–	4.25
Venkatesh [32]	12.2	8.8
Venkatesh [31]	–	3.75
Balent [39]	–	4

Costs

In the developing world, the cost per case of providing phacoemulsification ranges from $25.55–$70, compared to $15–$17 for MSICS (Table 6). The wide variation in the cost of phacoemulsification relates to the varying case volumes, over which the fixed costs of expensive instrumentation are spread out. For example, Muralikrishnan et al. [44] reported a cost per case of $25.55 for phaco in a high-volume center in India. The IOL cost also significantly influences the overall cost per case. For instance, Ruit et al. [30] reported a cost of $70 for phacoemulsification of which $52 was the cost of the most expensive foldable acrylic IOL. In comparison, the cost of a PMMA lens used in MSICS was only $5. If a cheaper IOL was used instead of a foldable acrylic IOL, then the cost of phacoemulsification as estimated by Ruit et al. [30] should be in the $25 range as reported by Muralikrishnan et al. [44] and Gogate et al [45]. Compared to phaco, MSCIS clearly emerges as the more cost-effective option. Phaco entails a larger initial capital expense, higher per case consumable costs (phacoemulsification tips, sleeves, and tubing), and higher ongoing maintenance costs [44]. Another disadvantage of phacoemulsification for some rural developing world settings is the requirement for a dependable source of electricity. In contrast, the only significant capital equipment expense for MSICS is the operating microscope, and this can be powered by a battery or small diesel generator [44].

Of course, which procedure is more affordable and cost-effective depends on other factors besides just the consumable supplies and amortized capital equipment costs. These include facility costs, nursing and staff salaries, and pre- and postoperative care, medications, and visits. Health-care delivery systems that most efficiently perform higher volume surgery while safely minimizing cost are providing the most cost-effective care in the developing world. In this context, the higher procedural volumes attainable with MSICS provide further advantages in terms of cost-effectiveness.

Outcomes

Comparison to Phacoemulsification

Three randomized prospective studies conducted in developing countries have compared phacoemulsification with MSICS. In these, MSICS was comparable to phaco in achieving excellent visual outcomes (Table 7) [30, 31, 32]. Venkatesh et al. [32]

Table 6 Provider's cost (US$) of phacoemulsification and MSICS

Study	Phaco	MSICS
Muralikrishnan [45]	25.55	17.03
Gogate	42.10	15.34
Ruit [30]	70	15

Table 7 Percentage of postoperative visual outcomes of phacoemulsification and MSICS

	UDVA						CDVA					
	Venkatesh [32] (at 6 weeks)		Gogate [31] (at 6 weeks)		Ruit [30] (at 6 months)		Venkatesh [32] (at 6 weeks)		Gogate [31] (at 6 weeks)		Ruit [30] (at 6 months)	
	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS	Phaco	MSICS
6/6–6/9	45.1	36.4	36.8	31.6	53.7	31.5	92.0	83.8	77.8	85.6	94.4	88.9
6/6–6/18	42.5	45.3	44.3	38.5	31.5	57.4	7.1	14.5	20.5	12.8	3.7	9.2
6/24–6/60	11.5	16.6	18.4	28.9	14.8	11.1	0.9	1.7	1.1	1.6	1.9	1.9
<6/60	0.9	1.7	0.5	0			0	0	0.5	0		

UDVA uncorrected distance visual acuity, *CDVA* corrected distance visual acuity randomized 270 consecutive patients with white cataracts to phacoemulsification and MSICS and found that uncorrected visual acuity of 6/18 or better was achieved in 87.6 % of eyes in the phacoemulsification group and 82 % of eyes in the MSICS group by 6 weeks postoperatively. The corresponding best corrected visual acuity of 6/18 or better was achieved in 99 % from the phacoemulsification group and 98.2 % from the MSICS group by 6 weeks postoperatively.

Gogate et al. [31] compared phacoemulsification with MSICS in a prospective randomized trial of 400 eyes and reported that uncorrected visual acuity of 6/18 or better was achieved by 81.08 % of the phacoemulsification eyes, vs. 71.1 % of the MSICS eyes at 6 weeks postoperatively. The best corrected visual acuity was 6/18 or better in 98.4 % of the phacoemulsification group and in 98.4 % of the MSICS group at 6 weeks postoperatively. These studies suggest that both techniques achieved similar results in terms of best corrected visual acuity at 6 weeks.

Ruit et al. [30] reported longer-term outcomes in a randomized prospective trial of 108 eyes in Nepal. The patients were randomized to MSICS or phaco, with each type of surgery performed by an acknowledged expert in that technique. They reported comparable rates of 98 % achieving best corrected visual acuity of 6/18 or better at 6 months postoperatively. Uncorrected visual acuity was comparable at 6 months.

A number of other studies [21, 38, 40, 43, 46] document good postoperative visual outcomes with MSICS (Table 8).

Summary

Although phacoemulsification is the preferred cataract surgical method in developed countries, MSICS is gaining strong popularity in many developing world settings where the backlog of cataract blindness persists due to the lack of health-care resources, funding, and eye surgeons. MSICS reduces the consumable costs per case as well as the capital and maintenance costs for phaco equipment. As a faster procedure, it permits higher daily case volumes compared to phaco. Although experienced surgeons achieve comparable visual outcomes and complication rates with both procedures, MSICS is safer in the hands of novice and less experienced

Table 8 Percentage of postoperative visual outcomes of MSICS

	UDVA			CDVA		
Study	6/6 – 6/18	6/24 – 6/60	<6/60	6/6 – 6/18	6/24 – 6/60	<6/60
Venkatesh [38]	43.9	51	5.3	94.4	4.0	1.6
Hennig [21]	70.5	28	1.5	96.2	3.6	0.2
Trivedy [40]	81.8	15.7	5.2	NA	NA	NA
Gogate [48]	47.9	47.7	4.3	89.8	8.4	1.7
Venkatesh [43]	78.4	21.5	0	97.1	2.9	0

UDVA uncorrected distance visual acuity, *CDVA* corrected distance visual acuity