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Modified manual small incision cataract surgery technique for phacoemulsification-trained surgeons

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Abstract

Purpose: To present the technique and outcomes of a modified manual small incision cataract surgery designed for the phacoemulsification surgeons who are learning to perform manual small incision cataract surgery.

Methods: This was a retrospective, single-centred, comparative study. We included all the patients who underwent the modified manual small incision cataract surgery for visually significant cataract at Singapore National Eye Centre. All surgeries were performed by either a senior phaco-trained surgeon (M.A.) who had performed more than 500 manual small incision cataract surgery or a junior phaco-trained surgeon (D.C.) who had performed around 500 phacoemulsification but never performed any manual small incision cataract surgery. The main modification of this technique lies in the creation of an additional phaco-like main wound at 90° to the scleral tunnel wound, with most surgical steps performed through this additional wound. The outcomes were analysed and compared between the senior and junior surgeons. The main outcome measures were visual outcome and major intraoperative complications such as posterior capsular rupture and zonular dialysis.

Results: A total of 132 cases were included; 102 (77.3%) and 30 (22.7%) cases were performed by the senior and junior surgeons, respectively. Pre-operatively, 85.6% eyes had best-corrected visual acuity of counting fingers or worse. Postoperatively, the visual outcome at 1 month was similar between the senior and junior surgeons, with 68.7% eyes achieving a best-corrected visual acuity of ⩾6/12 ($p = 0.17$). No posterior capsular rupture, zonular dialysis or endophthalmitis was observed during the study period.

Conclusions: This modified technique may serve as a useful transition technique for the phaco-trained surgeons to develop skills in manual small incision cataract surgery, with demonstrable good visual outcome and safety.

Keywords: cataract, cataract surgery, phacoemulsification, small incision cataract surgery

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Introduction

Cataract is the leading cause of reversible blindness globally, with around 12.6 million of the world population being affected.[1] With the advent of phacoemulsification technology,[2] advancement in surgical instrumentation,[3,4] and rising expectations among cataract patients,[5] phacoemulsification is now considered the 'gold standard' cataract extraction technique in most developed countries. However, access to phacoemulsification technology and issues with affordability make the widespread use of this technique challenging in some developing countries or rural areas within large developed countries.[4] Furthermore, in communities where patients present late with brunescent or dense nuclear sclerotic cataracts, performing phacoemulsification can be very challenging and is associated with increased risk of complications such as corneal decompensation and posterior capsular rupture (PCR).[6]

Manual small incision cataract surgery (MSICS) has been found to be a safe and effective technique for manual cataract extraction.[7] The nucleus of the cataract is removed directly from the scleral tunnel wound without the need for sophisticated surgical technologies.[7] This enables a cost-effective treatment of cataract, which is particularly useful in healthcare settings that may be constrained by limited resources.[7] In addition, many studies have demonstrated comparable clinical outcomes between MSICS and phacoemulsification.[8,9] MSICS may also be useful technique to use in eyes with brunescent or intumescent white cataracts.[10] Moreover, it has the advantage of a potentially self-sealing wound that may obviate the need for suturing, thus reducing surgical-induced astigmatism compared to extracapsular cataract extraction (ECCE).[11]

Both phacoemulsification and MSICS are associated with a learning curve.[12,13] However, MSICS has been reported to have a potentially steeper learning curve, especially for junior surgeons who are not familiar with manual cataract extraction techniques. Recently, Gupta and colleagues[13] evaluated more than 13,000 MSICS surgeries performed by the residents and highlighted that the risk of surgical complications and reoperations in MSICS was greater in residents with minimal surgical experience. It was recommended that residents required a minimum of 300 or more supervised MSICS cases in order to achieve an intraoperative and postoperative complication rate of less than 2%.[13] They also reported that surgeries performed by experienced residents (more than 600 MSICS surgeries) achieved an additional 4-Snellen line improvement in vision compared to those performed by inexperienced residents (<100 surgeries).[14] These results highlight the need for a systematic training strategy and techniques tailored for junior surgeons in training.

Moreover, there has been an increasing interest among surgeons, who are already experienced in phacoemulsification, to perform MSICS in challenging scenarios such as eyes with brunescent cataracts, zonulysis, or angle closure.[7] It may also be a useful technique to switch to when faced with complications such as extensive capsular zonulysis or PCR during phacoemulsification.[15] However, the MSICS learning curve for surgeons who are only familiar with phacoemulsification can be steep. Thus, we present a step-by-step guide to a modified MSICS technique for the modern-day phacoemulsification surgeons, who have minimal or no experience in MSICS. We also aim to report the outcome and safety of this modified technique in the hands of both senior and junior phaco-trained surgeons.

Materials and methods

This was a retrospective, single-centred, consecutive, comparative study conducted at the Singapore National Eye Centre, Singapore, between June 2018 and May 2019. All surgeries were performed by either a senior surgeon (M.A.) who had performed more than 1000 phacoemulsifications and more than 500 MSICS or a novice surgeon (D.C.) who had performed more than 500 phacoemulsifications but with no experience in MSICS and scleral tunnel technique. Inclusion criteria of this study included patients with significant cataract with a best-corrected visual acuity (BCVA) of 6/60 or worse and were able to attend a follow-up visit at 1-month postoperative. Patients were excluded if there was any history of ocular comorbidities such as amblyopia, corneal pathology, glaucoma, retinal, or macular damage.

The modified MSICS technique used in this study was adapted from the conventional MSICS technique as previously described.[16] For this study purpose, both surgeons employed the same modified MSICS technique. Briefly, after dilating the pupil pre-operatively, a temporal or superior limbal conjunctival peritomy, spanning 3 to 4 clock hours, was performed with diathermy to achieve hemostasis. A scleral tunnel (6–7 mm in width) was then fashioned starting from 2 mm posterior to the limbus and was advanced anteriorly along the plane of sclera and mid-posterior corneal stroma until approximately 1 to 2 mm beyond the limbus without entering the anterior chamber (Figure 1(a)).

Next, a 2.65 mm clear corneal tunnel (CCT) was created, at 90° from the scleral tunnel, using a keratome in a similar fashion to the main wound created during routine phacoemulsification (Figure 1(b)). This wound would be more intuitive for phaco-trained surgeons to perform the subsequent steps of cataract surgery and manoeuvre the instruments within the anterior chamber through a more instinctive downwards,

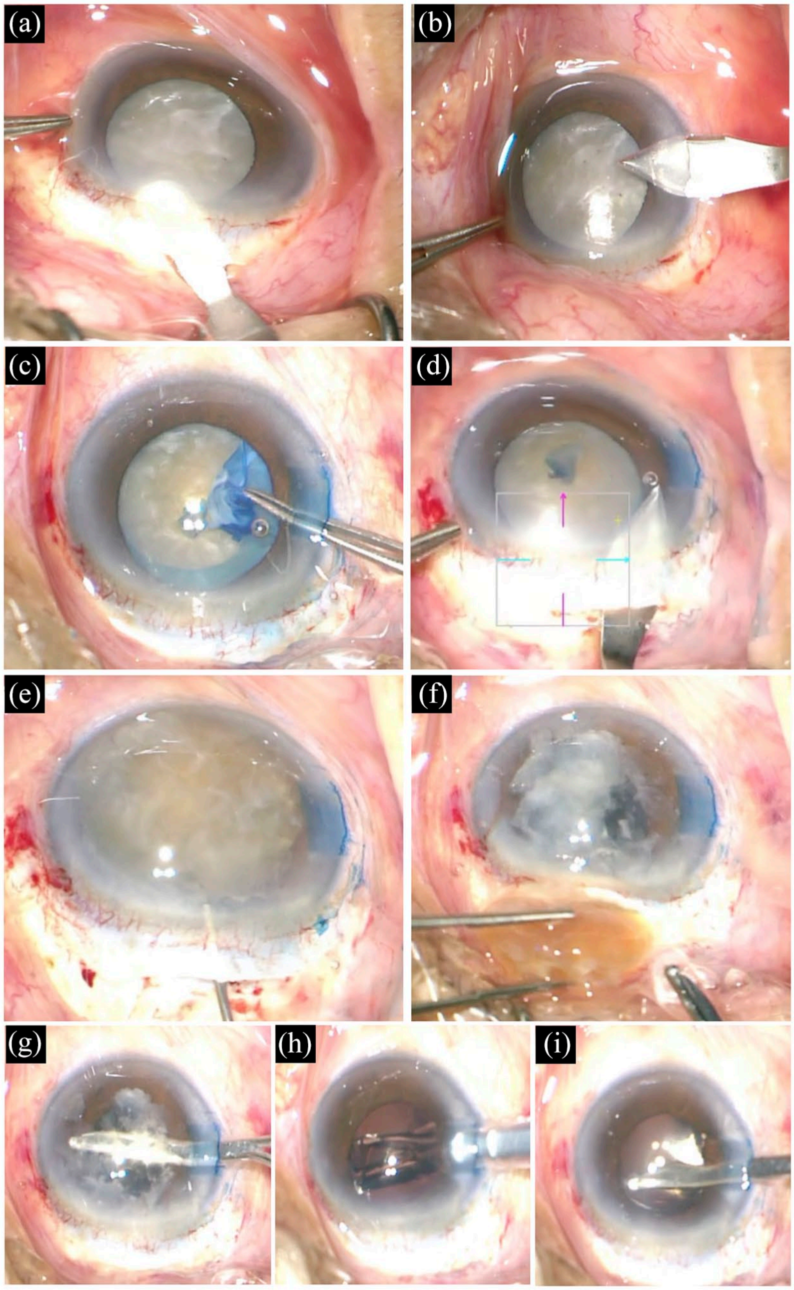

Figure 1. Various steps of the modified manual small incision cataract surgery (MSICS): (a) a scleral tunnel (6–7 mm in width) is being created, starting from 2 mm posterior to the limbus, and advanced anteriorly along the plane of sclera and mid-posterior corneal stroma until approximately 1 to 2 mm beyond the limbus without entering the anterior chamber. (b) A clear corneal tunnel is being created, at 90° from the scleral tunnel, using a keratome in a similar fashion to the routine phacoemulsification. (c) an anterior continuous curvilinear capsulorrhexis is being performed through the clear cornea tunnel (CCT). (d) The scleral tunnel wound is being further enlarged internally within the cornea so that the inner wound was larger than the outer wound (a 'funnel-shaped' wound). (e) After hydrodissection, viscodissection is performed to prolapse the nucleus out from the capsular bag into the anterior chamber and out through the scleral tunnel wound, with pressure exerted on the posterior scleral tunnel wound edge. (f) The nucleus is completely removed from the anterior chamber. Through the CCT, irrigation and aspiration of cortical matter (g), insertion of an intraocular lens (h), and removal of viscoelastic are performed (i).

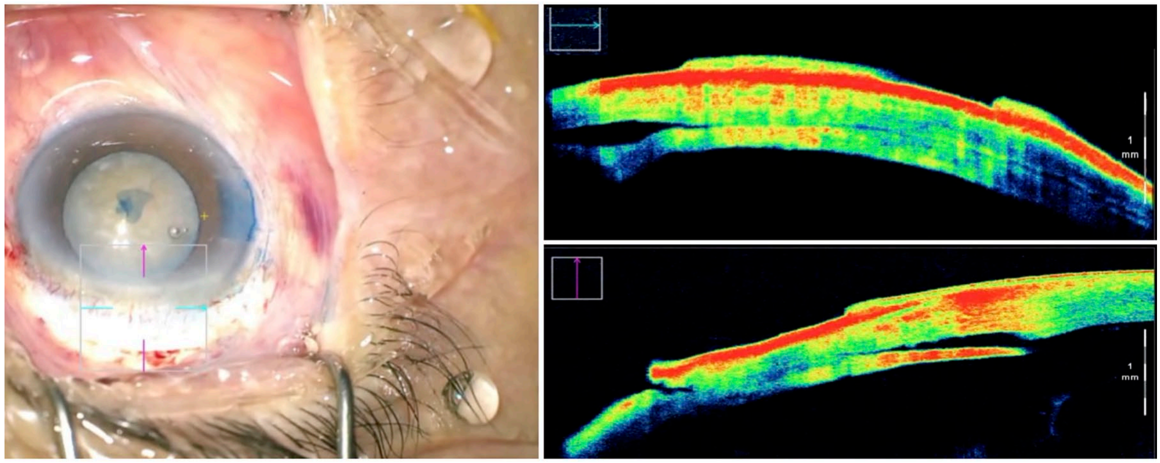

Figure 2. Intraoperative anterior segment optical coherence tomography showing the cross-section of the scleral tunnel wound, with an upwards, posterior-to-anterior morphology.

anterior-to-posterior wound (similar to performing phacoemulsification) instead of an upwards, posterior-to-anterior scleral tunnel wound (Figure 2). A smaller corneal incision (e.g. 2.2 or 1.8 mm) can also be considered, though the majority of pre-loaded intraocular lens (IOL) cartridge would go through a 2.65 mm wound.

Trypan blue (VisionBlue®, D.O.R.C., Zuidland, Netherland) was used to stain the anterior capsule in all cases in view of poor red reflex. Subsequently, an anterior continuous curvilinear capsulorrhexis was performed through this CCT (Figure 1(c)). The scleral tunnel wound was then further enlarged internally within the cornea so that the inner wound was larger than the outer wound (a 'funnel-shaped' wound; Figure 1(d)). Hydrodissection was subsequently performed, followed by a viscodissection to prolapse the nucleus out from the capsular bag into the anterior chamber and out through the scleral tunnel wound, with pressure exerted on the posterior scleral tunnel wound lip (Figure 1(e)–(f)). During nucleus delivery, introduction of any other instrument underneath the nucleus was not recommended for the junior surgeons as it might cause inadvertent damage of the posterior lens capsule due to the view being obscured by the dense cataract. Irrigation and aspiration of cortical matter as well as intraocular lens insertion and removal of viscoelastic were all performed through the CCT (Figure 1(g)–(i)). Finally, the wound was sealed with hydration and a safety suture was inserted through the scleral tunnel wound at the conclusion of surgery in all cases. This was because the scleral tunnel might not be self-sealing during the initial learning curve. Postoperative medications included topical moxifloxacin 0.5% four times a day (QID) for 4 weeks and topical dexamethasone 0.1% six times a day for 1 week then QID for 4 weeks. A step-by-step guide to this modified MSICS technique is provided in Table 1 and Supplemental Video 1.

Outcome measures

The main outcome measures were BCVA at 1-month follow-up, risk of major intraoperative complications (including PCR, vitreous loss and zonular dialysis), and postoperative complications (including endophthalmitis, retinal detachment, hyphaema, raised intraocular pressure (IOP; >21 mmHg) and central corneal oedema) at 1-week and 1-month postoperative follow-up. Central corneal oedema was defined as the presence of stromal oedema and/or descemet membrane folds affecting the visual axis. The outcomes between the senior and junior surgeons were analysed and compared.

Statistical analysis

All data were entered onto an Excel (Microsoft, Redmond, Washington, USA) spreadsheet and statistical analysis was performed using SPSS version 24.0 (IBM SPSS Statistics for Windows, Armonk, NY, USA). Comparison between groups was conducted using Pearson's chi-square or Fisher's Exact test where appropriate for categorical variables and unpaired T-test or Mann–Whitney U-test for continuous variables. Normality of data distribution was assumed if the

Table 1. A step-by-step guide of modified manual small incision cataract surgery (MSICS) surgical technique for the phaco-trained surgeons.

Surgical Steps	Description
1. Conjunctival peritomy and scleral tunnel (6–7 mm)	A large and long scleral tunnel should be routinely performed during learning curve to allow safe delivery of most nucleus sizes without disrupting the tunnel or damaging iris.
2. A large 2.65 mm corneal wound as a second port of entry	Large two-step corneal wound 90° to scleral tunnel, to allow most steps to be performed through to avoid instrumentation in and out of scleral tunnel and a more intuitive downwards manipulation of instruments.
3. Capsulotomy	Routine vision blue staining with continuous curvilinear capsulorhexis through corneal wound is more resilient without anterior capsule tags. Relaxing anterior capsule incisions may still be required.
4. Nucleus delivery	Hydrodissection followed by viscodissection of the nucleus into the anterior chamber. Injecting viscoelastic to protect the posterior capsule and endothelium and depressing on the posterior scleral tunnel wound edge to deliver the nucleus slowly. Avoid inserting instruments into the bag or behind the nucleus where there is no view of the posterior capsule.
5. Irrigation and aspiration	Removal of lens cortical material through the corneal wound is more intuitive and maintains the anterior chamber with a sealed wound and downwards movement of instruments.
6. Intraocular lens insertion	Insertion of folded intraocular lens (IOL) through the corneal wound is familiar to surgeons who only have prior phacoemulsification, before transitioning to insertion of rigid one-piece IOL.
7. Wound closure and conjunctival peritomy closure	One or more sutures may be required for a secure wound, especially if a large scleral tunnel was constructed for easy atraumatic delivery of the nucleus.

skewness and kurtosis z-values were between –1.96 and +1.96 and the Shapiro–Wilk test p value was >0.05. All continuous data were presented as mean ± standard deviation (SD). P value of <0.05 was considered statistically significant.

Ethical approval was not required as this study was a retrospective review of medical case notes, and only anonymised data were collected and analysed. The conduct of study adhered to the tenets of Declaration of Helsinki. Informed consent was obtained from all patients prior to the surgery.

Results

A total of 132 consecutive modified MSICS cases using the described technique were performed and included in this study. Of all, 102 (77.3%) and 30 (22.7%) cases were performed by the senior surgeon and the junior surgeon, respectively (Tables 2 and 3). The type of cataract was either brunescent (83, 63.9%), white (21, 15.9%) or posterior subcapsular cataract (28, 21.2%), with no significant difference between the senior and junior surgeons (Table 2). All cases performed by the junior surgeon were carried out independently but under the supervision of a senior surgeon who did not intervene during the surgery.

Pre-operatively, majority (85.6%) of eyes had BCVA of counting fingers (CFs) or worse. Postoperatively, 90 (68.7%) eyes achieved a BCVA of ⩾6/12 at 1 month. The postoperative visual outcome was similar between the senior and junior surgeons (p = 0.17; Table 2). Seven cases had a postoperative BCVA of 6/60 or worse at 1-month postoperative, due to central corneal oedema (n = 4) and undiagnosed macular scar (n = 2) and glaucoma (n = 1). The risk of postoperative complications observed in our study was low and similar between the senior and junior surgeons (p = 0.59; Table 2). No major

Table 2. A comparison of pre-operative and postoperative characteristics of MSICS between the senior and junior surgeons.

Variables	Senior Surgeon (*n* = 102)	Junior Surgeon (*n* = 30)	*p* value
Age: mean (±SD)	64.7 (8.7)	66.9 (9.8)	0.24
Gender: Male; *n* (%)	37 (36.3)	10 (33.3)	0.77
Laterality: Right; *n* (%)	67 (65.7)	11 (36.7)	0.004
Type of cataract; *n* (%)			0.37
Brunescent (>NS4+)	67 (65.7)	16 (53.3)	
White	16 (15.7)	5 (16.7)	
PSC	19 (18.6)	9 (30)	
Pre-op BCVA: *n* (%)*			0.95
PL	3 (3.0)	1 (3.3)	
HM	16 (15.8)	4 (13.3)	
CF	69 (68.3)	20 (66.7)	
6/60	13 (12.9)	5 (16.7)	
AXL; mean (±SD)	22.8 (0.9)	22.8 (0.9)	0.89
K1; mean(±SD)	43.9 (1.3)	44.3 (1.3)	0.22
K2; mean(±SD)	44.7 (1.3)	45.0 (1.4)	0.27
Mean K; (±SD)	44.3 (1.3)	44.6 (1.4)	0.23
IOL Power; mean (±SD)	21.9 (2.6)	21.7 (3.1)	0.66
Target refraction; mean (±SD)	−0.21 (0.15)	−0.23 (0.14)	0.46
Post-op BCVA; *n* (%)*			0.17
⩾6/9	35 (34.3)	8 (26.7)	
<6/9 to ⩾6/12	40 (39.6)	8 (26.7)	
<6/12 to >6/60	21 (20.8)	12 (40.0)	
⩽6/60	5 (5.0)	2 (6.7)	
Post-op complications; *n* (%)**			0.21
Hyphaema	0 (0.0)	1 (3.3)	
Central corneal oedema	2 (2.0)	2 (6.7)	
Raised IOP (>21 mmHg)	9 (8.8)	2 (6.7)	

Continuous variables = T-test; categorical = χ^2 test or Fisher's Exact test.
SD, standard deviation; NS, nuclear sclerosis; PSC, posterior subcapsular cataract; BCVA, best-corrected visual acuity; PL, perception of light; HM, hand movement; CF, counting fingers; AXL, axial length; IOL, intraocular lens; IOP, intraocular pressure.
*There was one missing data in the senior surgeon group, so the total *N* was 101.
**Postoperative complications were assessed at 1-week and 1-month follow-up. All cases of hyphaema and raised IOP resolved by 1-month follow-up, but central corneal oedema remained visible at 1-month follow-up.

Table 3. A comparison of the demographic and clinical characteristics between eyes with brunescent and white/posterior subcapsular (PSC) cataract performed by the senior surgeon.

Variables	Brunescent (n = 67)	White/PSC (n = 35)	p value
Age: mean (±SD)	65.3 (8.8)	63.7 (8.3)	0.38
Gender: Male; *n* (%)	23 (34.3)	14 (40)	0.57
Laterality: Right; *n* (%)	45 (67.2)	22 (62.9)	0.66
Type of cataract; *n* (%)			NA
Brunescent (>NS4+)	67(100)	0	
White	0	16 (45.7)	
PSC	0	19 (54.3)	
Pre-op BCVA; *n* (%)*			0.23
PL	2 (3.0)	1 (2.9)	
HM	7 (10.6)	9 (25.7)	
CF	49 (74.2)	20 (57.2)	
6/60	8 (12.1)	5 (14.3)	
AXL; mean (±SD)	22.8 (0.9)	22.9 (1.0)	0.56
K1; mean (±SD)	44.0 (1.3)	43.9 (1.3)	0.81
K2; mean (±SD)	44.8 (1.4)	44.5 (1.3)	0.38
Average K; mean (±SD)	44.4 (1.4)	44.2 (1.2)	0.56
IOL Power; mean (±SD)	21.9 (2.7)	21.9 (2.5)	0.95
Target refraction; mean (±SD)	−0.20 (0.15)	−0.22 (0.14)	0.55
Post-op BCVA; *n* (%)*			0.99
⩾6/9	23 (34.8)	12 (34.3)	
⩾6/12	49 (74.2)	26 (74.3)	
⩾6/18	58 (87.9)	32 (91.4)	
Safety index; mean (±SD)*	93.8 (148.1)	167.7 (218.9)	0.08

Continuous variables = T-test; categorical = χ^2 test or Fisher's Exact test.
SD, standard deviation; NS, nuclear sclerosis; BCVA, best-corrected visual acuity; PL, perception of light; HM, hand movement; CF, counting fingers; NA, not applicable; AXL, axial length; IOL, intraocular lens; IOP, intraocular pressure.
*There was one missing data in the brunescent cataract group.

intraoperative complication such as PCR, vitreous loss or zonular dialysis was observed during the study period. The most common postoperative complication noted at 1-week follow-up was raised IOP (n = 11, 8.3%), followed by central corneal oedema (n = 4, 3.0%) and hyphaema (n = 1, 0.8%). At 1-month follow-up, all cases of raised IOP had been successfully treated with topical medications and the hyphaema had resolved. Four cases of persistent, but resolving, central corneal oedema were noted at 1-month postoperative. We did not observe any major postoperative complications such as endophthalmitis or retinal detachment during the follow-up. There was no additional secondary operation required to manage any of the described complication.

Discussion

In this report, we report the outcomes of a modified MSICS technique designed for the phaco-trained surgeons who are keen to develop skills in MSICS. We observed that good clinical outcomes can be achieved with this modified technique, in the hands of both senior and junior surgeons, with minimal risk of intraoperative and postoperative complications.

The key part of this technique lies primarily in the creation of an additional CCT that is similar to the main wound created during phacoemulsification, for which the advantages are at least twofold. First, this modified technique allows the phaco-trained surgeons to operate and manoeuvre instruments into the eye through a more familiar and intuitive downwards, anterior-to-posterior CCT wound instead of an upwards, posterior-to-anterior scleral tunnel wound. This may reduce the risk of intraoperative complications such as capsulorrhexis radialisation (caused by anterior chamber instability) and corneal decompensation (due to inadvertent damage from the instruments inserted in a posterior-to-anterior manner into the eye pointing towards the endothelium). Second, operating through a second CCT helps minimise excessive manoeuvring of instruments through the scleral tunnel, which can inadvertently compromise the self-sealing property of the wound. Once the surgeon becomes familiar with manoeuvring instruments through the scleral tunnel, this step may be then reverted back to a small side-port incision and most of the surgical steps can be done through the tunnel instead. We fashioned the scleral tunnel in an inverted funnel-shaped configuration so that the inner wound size was sufficiently large to enable a smooth delivery of nucleus via visco-expression alone (without any additional gliding instrument such as irrigating vectis or fishhook) while minimising the external wound size to encourage a self-sealing wound.

A study highlighted that the most common intraoperative complication of MSICS among the junior surgeons (during their first 10 cases in training) was wound leak requiring intraoperative suturing (33%), followed by vitreous loss (6.7%) and capsulorhexis radialisation (6.7%).[17] In a similar vein, Gupta and colleagues[13] examined the rate of major complications of MSICS performed by residents and found that the intraoperative and first-day postoperative complication rates among inexperienced residents (<100 cases) were 4.1% and 2.3%, respectively. In addition, Lynds and colleagues[18] examined the outcome and complication rate of 52 MSICS cases performed by resident surgeons in the United States and observed that iris prolapse (9.6%), zonular dialysis (7.7%), and vitreous loss (1.9%) could occur. Our technique was used successfully to teach a resident who had no prior experience in MSICS and scleral tunnel to perform cases safely and achieve similar surgical outcomes and complication rate as the senior surgeon with no incident of PCR, vitreous loss or zonular dialysis, albeit in a small number of consecutive cases. In addition, we observed a low rate of central corneal oedema (3.0%) at 1-month postoperative, which was comparable to the results published in the literature.[18] Moreover, practicing surgical steps through the additional CCT may enable the junior surgeon to convert a phacoemulsification to MSICS by creating a scleral tunnel 90° to the original phacoemulsification wound, if complications such as PCR or zonular dialysis occur.

In the description of this modified technique, we also used intraoperative optical coherence tomography (OCT) to demonstrate the principles discussed, which may be useful when training residents in the important steps during MSICS. This may help the residents to understand and visualise the creation of the scleral tunnel and corneal wounds, and the different ways of manoeuvring instruments through the wounds safely. Recently, Ehlers and colleagues[19] demonstrated the value and generalised feasibility of intraoperative OCT on assisting surgeons in both anterior and posterior cataract surgery. Other strategies such as wet-laboratory and simulation training have also been shown to improve the clinical outcomes and safety of MSICS performed by residents.[20]

Many MSICS techniques recommend the use of instruments such as irrigation vectis, iris spatula, fish hook technique, Kansas trisector, Sinskey hook or wire loop stainless steel snare to extract the nucleus.[7] However, in order to enhance the safety of MSICS during the initial learning curve, we advocate to try and avoid introducing any instrument behind the lens during nucleus delivery and use injection of viscoelastic behind the nucleus while depressing on the posterior edge of the scleral tunnel.[21] This may reduce the risk of intraoperative complications such as PCR, zonulysis and iris trauma leading to intraoperative hyphaema.[22] However, it is important to ensure that the size of scleral tunnel is adequately large to enable smooth delivery of the lens. A temporal approach may be preferred to a superior approach for creating the scleral tunnel as it provides more space and accessibility to the junior surgeon, especially in Asian eyes or eyes with which are small and deep-set.[23] In addition, creating a slightly larger scleral tunnel wound at the initial stage of learning also helps to minimise excessive trauma induced by the instruments through a tight scleral tunnel wound. However, care needs to be taken as temporal clear corneal incision may increase the risk of postoperative endophthalmitis compared to superior sclerocorneal wound.[24] We recommend inserting a safety suture at the conclusion of the MSICS surgery during the initial learning phase to ensure that the scleral tunnel wound is completely secured.

One of the limitations of this modified technique is that the surgeons are required to shift their operating position between superior and temporal sites during certain steps. However, it would be beneficial if this technique can potentially reduce the risk of intraoperative and postoperative complications during the initial learning curve of MSICS. Future studies with a large sample size comparing the outcomes and risk of complications between this modified technique and conventional technique will be valuable. Some other innovative MSICS techniques have also been described in the literature to improve the outcome of MSICS.[25] For instance, Kosakarn[26] proposed using a double-nylon loop to manually phaco-fragment the nucleus into three pieces so that they can be delivered through a small (4.0–4.5 mm) sutureless scleral tunnel incision. Ianchulev and colleagues[27] described a micro-interventional phaco-free endocapsular lens fragmentation technique using a superelastic memory-shaped nickel and titanium microfilament (miLOOP) to dissect the nucleus into many segments, which can then be delivered through small 2.3 mm corneal incision, avoiding a large corneal or sclerocorneal incision. Continuous infusion of hydroxymethyl cellulose (HPMC) through an anterior chamber maintainer may also be used during nuclear delivery to reduce endothelial cell loss, particularly for junior surgeons.[28] In addition, the novice surgeon was well trained in phacoemulsification cataract surgery and demonstrated better surgical proficiency than average novice surgeons. Therefore, the effectiveness and safety of this modified MSICS technique require further evaluation in less-experienced phacoemulsification-trained surgeons in order to determine its generalisability.

In conclusion, MSICS remains an important and useful technique for managing cataract in the modern-day ophthalmology, in both developed and developing countries. A number of steps deserve particular attention during the initial learning curve of MSICS, including creation of a self-sealing scleral tunnel and atraumatic nucleus expression, and our modified technique aimed to help ease the learning curve for phaco-trained surgeons.

Conflict of interest statement

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Supplemental material

Supplemental material for this article is available online.

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