ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)
Available Online at:www.ijmacr.com
Volume – 9, Issue – 1, February - 2026, Page No.: 182 – 191

The Safety and Efficacy of Anterior Chamber (AC) Maintainer in Manual Small Incision Cataract Surgery (MSICS) vs Ophthalmic Visco Surgical Devices (OVD) A Quasi Experimental Study in Tertiary Care Centre

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How to citation this article: Dr Siddhesh Basavraj Khajuragi, Dr Poonam Namdev Kalyanpad, Dr Atul Sheshrao Raut, "The Safety and Efficacy of Anterior Chamber (AC) Maintainer in Manual Small Incision Cataract Surgery (MSICS) vs Ophthalmic Visco Surgical Devices (OVD) A Quasi Experimental Study in Tertiary Care Centre", IJMACR- February - 2026, Volume – 9, Issue - 1, P. No. 182 – 191.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Cataract remains the leading cause of blindness worldwide and manual small incision cataract surgery (MSICS) is the most widely adopted technique in developing countries, where phacoemulsification is not financially viable.

Aims and Objectives

Primary Objectives: To evaluate safety and efficacy of AC Maintainer in manual small incision cataract surgery, with reference to visual outcome.

Other Objectives: To study intraoperative complications, postoperative complications and outcomes.

Material and Method:

Study Design: Quasi Experimental study

Study Period: The study was conducted over a period of 18 months

Place of study: The study was conducted at Department of Ophthalmology at Tertiary Care Center.

Sample Size: Total sample size were 133 and randomly collection

Sampling Method: Complete Enumeration method

Result: Sample size is determined by Complete Enumeration method Minimum sample size were 133 and compared to preoperative values, Group I is VISCO group with N=30 and Group II is AC Maintainer also N=30.

Discussion: The current study, investigating a new type of anterior chamber maintainer (ACM) and to its reveal a higher incidence of intraoperative and early postoperative complications with its use compared to ocular viscosurgical devices (OVD).

Keywords: Blindness, Couching, Capsular Bag, ECCE, Surgical Cost

Introduction

Cataract is currently the main cause of avoidable blindness in the developing world accounting for about three quarters of blindness[1]. Indians were the first to begin operations on cataract by mastering the technique of "Couching". "Sushruta" practiced this technique in 800 BC and is considered as the father of cataract surgery[2]. Minassian and Mehra[2] estimated that in India, annually 3.8 million people become blind from cataract.

Manual small incision cataract surgery (MSICS) has emerged as the cost effective technique for cataract surgery[3,4] when compared with extra capsular cataract extraction (ECCE) and phacoemulsification.

Maintenance of optimal fluid dynamics is a key factor in achieving a safe and well-controlled surgical procedure. In the early evolution of modern manual cataract surgery, fluidics was predominantly employed during cortical aspiration.

The introduction of ophthalmic visco surgical devices (OVD) was significant improvement and OVDs are used to reform and maintain a stable AC and capsular bag and to safely perform continuous capsulorrhexis and in the bag placement of IOL.

These devices protect the endothelium and can enhance pupil mydriasis at the same time. There are some possible side effects of OVDs, blockage of microincisions by OVDs can cause posterior capsular rupture. Excessive injection of OVDs forms a risk factors of Floppy Iris Syndrome. Postop IOP spike are well known side effects of OVDs and entrapped OVD in the capsular bag can cause early postoperative myopia and inflammation. Aspiration of the OVD after lens implantation necessitates additional surgical manipulation and timing adjustments during the procedure. New OVD improve the protection of corneal endothelium but increases the surgical cost at the same time.

Given the possible side effects of OVDs viscoless cataract surgery is possible option. Dr David McIntyre was the first to use fluidics to his advantage during cortex aspiration, mimicking the phaco fluid during cortex aspiration

Dr. Michael Blumenthal first introduced a cannula in the AC made from a child's IV butterfly set to introduce the flow of BSS into the AC. Later he used to the Lewicky ACM cannula and then his own design typical the oval Blumenthal ACM cannula (B&D58149).

The present study evaluated a novel type of anterior chamber maintainer (ACM) and revealed a higher incidence of intraoperative and early postoperative complications associated with its use compared to ophthalmic viscoelastic devices (OVDs).

Material and Method

Study Design: Quasi Experimental study

Study Period: The study was conducted over a period of 18 months

Place of study: The study was conducted at Department of Ophthalmology at Tertiary Care Center.

Sample Size: Total sample size were 133 and randomly collection

Sampling Method: Complete Enumeration method

Patients were randomly allocated into two groups:

Group A (ACM Group): MSICS performed using an anterior chamber maintainer with continuous infusion of balanced salt solution (BSS)

Group B (OVD Group): MSICS performed using ophthalmic viscoelastic devices for anterior chamber maintenance

Inclusion criteria

- Patients aged ≥ 40 years with age-related senile cataract
- Patients scheduled for elective manual small incision cataract surgery (MSICS)
- Best corrected visual acuity (BCVA) ≤ 6/18 due to cataract
- Clear cornea allowing adequate visualization of anterior segment
- Normal intraocular pressure (IOP) (10–21 mmHg)
- Pupillary dilation ≥ 6 mm preoperatively
- Patients willing to participate and provide informed consent.

Exclusion criteria

- Patients having comorbid conditions other than cataract which could affect visual outcome, such as
- Traumatic cataract
- Mature, Hypermature Cataract with zonular weakness
- Glaucoma or ocular hypertension
- Pseudoexfoliation syndrome with zonular instability
- Small pupil not adequately dilated(<6mm)
- Posterior segment involvement,
- Post uveitis changes,
- Corneal opacity/haze/degeneration/dystrophies/scars, and
- Who were unfit for surgery under local anesthesia due to systemic contraindications.
- Patient with previous ocular surgery in operated eye.
- Inflammatory conditions diseases such as iritis
- Retinal pathology exudative age related macular degeneration, proliferative diabetic vitreoretinopathy, retinal ischemic diseases
- Patients with glaucoma(open angle, secondary)
- Patients with floppy iris syndrome and on Tamsulosine.
- Sublux and dislocated lens
- Intraoperative complications requiring conversion of technique

Preoperative Evaluation

All patients underwent:

Detailed ocular history and systemic examination

Visual acuity assessment (Snellen chart)

Slit-lamp examination

Intraocular pressure measurement (tonometry)

Keratometry and A-scan biometry

Posterior segment evaluation (direct/indirect ophthalmoscopy)

Surgical Steps

The eye was fully dilated using E/D Tropicamide 0.8% + Phenylephrine 5%. Topical anaesthesia was given.

Preparation and Exposure

To stabilize the globe, a superior rectus bridle suture is placed.

Place the ACM port at the 6 o'clock limbus. Use a stiletto knife / MVR Blade to create a 1.0 mm wide by 1.5–2.0 mm long clear corneal tunnel, ensuring the blade remains parallel to the tissue to create a self-sealing entry. Intraocular pressure (IOP) is maintained between 30–40 mmHg by positioning the Balanced Salt Solution

(BSS) bottle approximately 40–50 cm above the patient's eye level.

Figure 1: AC Maintainer

Figure 2: MVR Blade

Incision and Tunnel Construction

A peritomy is performed to create a conjunctival flap from the 11 to 2 o'clock positions, roughly 1 mm from the limbus, followed by cautious diathermy for hemostasis. At 12 o'clock, a 4–6 mm straight external scleral incision is made 1 mm posterior to the limbus with a depth of 0.3 mm, incorporating Blumenthal side cuts. A self-sealing sclerocorneal tunnel is then dissected using a crescent blade.

Entry and Capsulotomy

A paracentesis is created at the 9 o'clock position using a 15-degree blade. The anterior capsule is stained with 0.1% trypan blue to improve visualization. Entry into the anterior chamber (AC) is completed using a 3.2 mm keratome, and a continuous curvilinear capsulorhexis (CCC) is performed with a 26G cystotome.

Nucleus Management and Extraction

Following hydrodissection with a 27G bent-tip cannula, the nucleus is prolapsed into the AC. A lens glide is positioned under the proximal third of the nucleus, and extraction is performed via the Mini-nuc technique.

Cortical Cleanup and IOL Placement

The remaining cortex is aspirated using a Simcoe cannula. Finally, a posterior chamber intraocular lens (PCIOL) is implanted into the capsular bag and dialed into the correct orientation.

Statistical analysis

Collected data entered in MS Excel. Quantitative data expressed in mean and standard deviation. Non normal data expressed in Median and Inter quartile range .Qualitative data expressed in frequency and percentage. Use appropriate test of significance (statistical test). If data do not follow normal distribution, use Mann Whitney U test. If $p<0.05$ statistically significant, otherwise non-significant.

Result

Table 1: Compared to preoperative values, Group I and Group II

	N	Mean	Std. deviation	Std Error Mean	t-value
VISCO (group1)	25	4.76	1.09	0.21	1.00 p=0.32
AC Maintainer (group2)	25	4.48	0.87	0.17	

In this, table 1 shown Compared to preoperative values, Group I is VISCO group with N=25 and Group II is AC Maintainer also N=25. In this VISCO (group1) means was 4.76 with standard deviation 1.09 and AC Maintainer (group 2) means was 4.78 with standard deviation 0.87. In this t value = 1.00 and significant statistical difference (P = 0.32) between two groups.

Graph 1: Compared to preoperative values, Group I and Group II

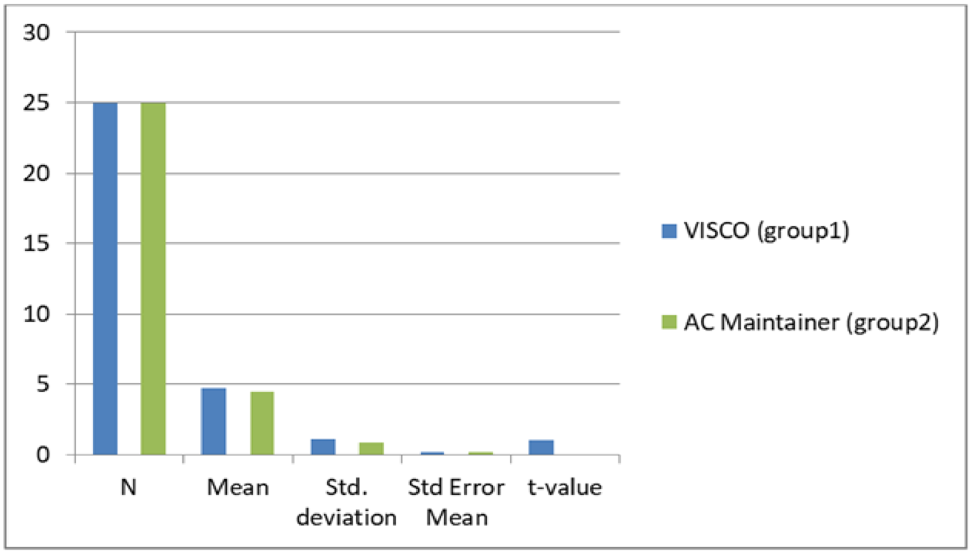

Table 2: Best Corrected Visual Acuity (BCVA)

Visual Acuity [Visco Group]	DAY 1	DAY 7	DAY 30	DAY 40	Visual Acuity [ACM Group]	DAY 1	DAY 7	DAY 30	DAY 40
6/6 – 6/12	13[43.33%]	17[56.67%]	23[76.67%]	27[90%]	6/6 – 6/12	15[50%]	20[66.67%]	24[80%]	28[93.33%]
6/18 – 6/36	14[46.67%]	13[43.33%]	7[23.33%]	3 [10%]	6/18 – 6/36	9 [30%]	10[33.33%]	6 [20%]	2 [6.67%]
6/60– FC 4M	3[10%]	-	-	-	6/60 – FC 4M	6[20%]	-	-	-
FC 3M– PL+	-	-	-	-	FC 3M – PL+	-	-	-	-
TOTAL	30	30	30	30	Total	30	30	30	30

Table 3: Corneal Edema (Slit Lamp Grading)

VISCO Group	POD1	1st week	2nd week	4th week
Grade 0	22(73.33%)	27(90%)	30(100%)	30(100%)
Grade 1	4(13.33%)	2(6.67%)	0	0
Grade 2	3(10%)	1(3.33%)	0	0
Grade 3	1(3.33%)	0	0	0
Grade 4	0	0	0	0
Total	30	30	30	30

ACM Group	POD1	1st week	2nd week	4th week
Grade 0	26(86.67%)	29(96.67%)	30(100%)	30(100%)
Grade 1	2(6.67%)	1(3.33%)	0	0
Grade 2	1(3.33%)	0	0	0
Grade 3	1(3.33%)	0	0	0
Grade 4	0	0	0	0
Total	30	30	30	30

Table 4: Intraocular pressure change in the patients

	Group 1 OVD-assisted IOL implantation	Group 2 BSS-assisted IOL implantation	p‡
Preoperative IOP	14.1±2.9	14.2±2.3	0.68
Postoperatve IOP†	17.1±2.5	17.3±3.5	0.72
Postoperative IOP - 1 day 0.72 0.005**	19.1±3.4	14.7±3.1	0.007*
Postoperative IOP - 1 week 0.19 0.23	13.8±3.1	13.2±1.5	0.35
Postoperative IOP - 1 month 0.13 0.14	13.2±2.9	13.8±2.7	0.25

BSS: balanced salt solution; IOL: intraocular lens; IOP: intraocular pressure; OVD: ophthalmic viscosurgical device; ‡ Independent samples t-test comparison of Group 1 and Group 2. † IOP was measured with a noncontact tonometer immediately following surgery; *The difference in postoperative IOP increase between groups was significant on day 1; ** The IOP increase was significant in Group 1 on day 1.

Table 4: Anterior chamber cells in both groups at the postoperative periods

	VISCO Group	ACM Group	*p*-value
POD1	3.3+	3.2+	0.841
1st week	1.6+	1.4+	0.744
1 month	0	0	0.425

At postoperative day 1, week 1, and month 1, the mean anterior chamber cell grades were 3.3+, 1.6+, and 0 in Group A, and 3.2+, 1.4+, and 0 in Group B, respectively, with no statistically significant differences observed between the groups at any time point.

Table 5: Frequencies of myopic shift and posterior capsule opacification

	VISCO Group	ACM Group	*p*-value
Myopic shift (>-1.5D)	4/30	0/30	0.113
Posterior capsule opacification	3/30	0/30	0.238

At three months postoperatively, a myopic shift greater than −1.5 diopters was observed in 4 out of 30 eyes in Group A, whereas no such shift was noted in Group B (0/30) (p = 0.113). At six months, posterior capsular opacification (PCO) was observed in 3 out of 30 eyes in Group A, while no cases were reported in Group B (p = 0.238).

Discussion

Manual small incision cataract surgery (MSICS) can be performed with optimal surgical satisfaction and visual results using an anterior chamber (AC) maintainer, even in settings with limited resources. The safety and efficacy of the AC maintainer were compared with an ophthalmic viscoelastic device (OVD) in a series of MSICS cases carried out in a tertiary care centre. A quasi-experimental, user-driven design recorded intraoperative adverse events, short-term postoperative events, and patient-reported outcomes.

Preoperative examination included uncorrected visual acuity (UCVA), refraction, best-corrected visual acuity (BCVA), colour vision testing, pupillary light reflex testing, slit-lamp examination of anterior segment, intraocular pressure measurement by the Noncontact tonometer, and posterior segment examination.

Conclusion

The safe, effective cataract surgery is critically important in resource-limited settings. This journey through cataract procedures performed at a tertiary care centre compares the safety and efficacy of an anterior chamber (AC) maintainer with the currently favoured ophthalmic viscoelastic device (OVD) for manual small-incision cataract surgery (MSICS). The objective is to improve understanding of MSICS instrument choice as well as the safety and efficacy of the AC maintainer under real-world conditions. Safety is assessed through intraoperative and early postoperative events; efficacy, through cataract removal, intraocular lens placement, visual recovery, and the duration and materials used during surgery.

The present study demonstrates that the anterior chamber (AC) maintainer is a safe, effective, and economical alternative to ophthalmic viscosurgical devices (OVDs) in manual small incision cataract surgery (MSICS).

Key conclusions include:

- Comparable visual outcomes between AC maintainer and OVD groups
- Significantly lower early postoperative IOP spikes with AC maintainer
- Minimal intraoperative and postoperative complications in both groups
- Reduced surgical cost and operative time with AC maintainer

Additional Surgical Advantages of AC Maintainer

The use of an anterior chamber (AC) maintainer offers several intraoperative advantages owing to the continuous infusion of balanced salt solution and maintenance of a stable intraocular environment. One of the most important benefits is that the anterior chamber remains well-formed throughout the surgery, which minimizes fluctuations in intraocular pressure and provides better control during surgical maneuvers. This stable chamber contributes to astigmatism-neutral surgery, as there is minimal distortion of the wound architecture during different stages of the procedure.

Tunnel construction and dissection are also facilitated by the presence of a well-maintained anterior chamber. The constant intraocular pressure provided by the AC maintainer creates counter-resistance, making scleral tunnel formation and internal dissection easier and more controlled, thereby reducing the risk of premature entry or tunnel-related complications.

In the event of posterior capsular rupture (PCR), the AC maintainer plays a protective role by maintaining positive pressure within the anterior chamber. This helps to limit the size of the capsular tear and reduces the chances of its extension. Additionally, the maintained chamber stability helps to prevent or minimize vitreous prolapse into the anterior chamber, thereby reducing the need for anterior vitrectomy and associated complications.

Another important advantage is the maintenance of adequate pupillary dilatation throughout the surgery. The continuous flow of irrigating solution helps in washing out inflammatory mediators such as prostaglandins, which are known to cause intraoperative miosis. As a result, the pupil remains well dilated, facilitating safer nucleus delivery and intraocular lens implantation.

Furthermore, the continuous irrigation leads to washout of inflammatory mediators, resulting in reduced postoperative inflammation compared to OVD-based techniques. This contributes to better patient comfort and faster recovery in the early postoperative period.

Cortical aspiration is also more efficient with the AC maintainer. The maintained chamber depth and continuous fluidics allow for easier and more complete removal of cortical material, reducing the risk of retained cortex and postoperative complications such as inflammation and posterior capsular opacification.

Overall, these advantages highlight that the AC maintainer not only provides a cost-effective alternative to OVDs but also enhances intraoperative safety, surgical efficiency, and postoperative outcomes.

Therefore, AC maintainer-assisted MSICS can be considered a cost-effective and clinically reliable technique, particularly in high-volume and resource-limited settings, without compromising surgical safety or patient outcomes.

Limitations of the Study: Lack of endothelial cell count and central corneal thickness measurements.

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