

**Visual outcome and postoperative complications after manual small incision cataract surgery versus phacoemulsification**

Mohammed Jalal EL Din Hanafy Elshaar<sup>a,\*</sup>, Mohammed Mahmoud Elsayed<sup>b</sup>, Ahmed Hassan Aldghaimy<sup>a</sup>, Wael Elshazly<sup>a</sup>

<sup>a</sup>Department of Ophthalmology, Faculty of Medicine, South Valley University, Qena, Egypt.

<sup>b</sup>Department of Ophthalmology, Faculty of Medicine, Cairo University, Cairo, Egypt.

**Abstract**

**Background:** Age-related cataract is the leading cause of blindness in the globe, accounting for 51% of all blindness. Most cataract cases occur in underdeveloped countries. MSICS (manual small incision cataract surgery) is a new procedure. As a common approach that combines all the benefits of phacoemulsification with the extra benefit of greater application,

**Objectives:** To compare visual outcome and postoperative complications after MSICS and Phacoemulsification.

**Patients and methods:** 100 eyes of 100 patients with senile cataract divided randomly into two groups. Group A 50 eyes underwent phacoemulsification, Group B: 50 eyes underwent Manual small incision cataract surgery (MSICS).

**Results:** Regarding to visual outcome, at 3 months, 44 patients 88% of phacoemulsification group had a best corrected distant visual acuity (BCDVA) of 6/12 or better as compared to 38 patients 78% in MSICS. In day one postoperative 96% of phacoemulsification group eyes exhibited moderate to severe corneal edema while only 14% of MSICS group exhibited moderate corneal edema, 2% severe edema the difference was statistically significant ( $p < 0.001$ ). Best corrected visual acuity after 3 months post operative was comparable between two groups however surgically induced astigmatism (SIA) after three months was statistically significant ( $p < 0.001$ ) with less SIA in phacoemulsification group compared to MSICS group with SIA. The incidence of Descemet's membrane detachment was also studied with no statistical significance between two groups with slightly higher rates in phacoemulsification group confined to incision site.

**Conclusion:** Both phacoemulsification and MSICS are effective techniques in treating senile cataracts with satisfactory visual outcome. While MSICS have slight edge in terms of cost and fewer complications rate, uneventful phacoemulsification yields faster visual rehabilitation with better refractive outcomes which is more convenient in nowadays patients.

**Keywords:** Cataract; Manual small incision; Cataract surgery; phacoemulsification.

**DOI:** 10.21608/svuijm.2022.95108.1217.

**\*Correspondence:** [mohamed.galal@svu.edu.eg](mailto:mohamed.galal@svu.edu.eg).

**Received:** 22 January, 2022.

**Revised:** 2 February, 2022.

**Accepted:** 23 February, 2022.

**Cite this article as:** Elshaar MGE-DH, Elsayed MM, Aldghaimy AH, Elshazly W. (2022). Visual outcome and postoperative complications after manual small incision cataract surgery versus phacoemulsification. *SVU-International Journal of Medical Sciences*. Vol.5, Issue 2, pp: 1-9.

**Copyright:** © Elshaar et al. (2022) Immediate open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge. Users have the right to Read, download, copy, distribute, print or share link to the full texts under a [Creative Commons BY-NC-SA](https://creativecommons.org/licenses/by-nc-sa/4.0/)

## Introduction

Age-associated cataract is still the leading cause of blindness in the globe, accounting for 51% of all blindness. Most cataract cases occur in underdeveloped countries. **(RR Bourne and colleagues, 2004)**. MSICS (manual small-incision cataract surgery) is a low-cost, small-incision alternative to extracapsular cataract extraction (ECCE), which is commonly used in underdeveloped countries. MSICS has the advantage of a self-sealing, suture-free wound as compared to the regular ECCE. MSICS provides several significant advantages over phacoemulsification in resource-constrained settings, including a shorter operative time, less reliance on technology, and cheaper cost.

Recent studies have found that individuals having phacoemulsification and MSICS with posterior chamber intraocular lens insertion have similar outcomes and complication rates. The most widely used MSICS methodology nowadays is based on the method first presented by **(Ruit S et al., 1999)**. However, **(Blumenthal et al., 1992)** detailed a manual ECCE technique that served as a foundation for further MSICS advancements. Phacoemulsification machines are costly to buy and repair, and they also add to the high cost of surgical supplies. In health-care systems where ophthalmologists are in insufficient supply, the significant surgical training required for phacoemulsification is unfeasible. Finally, hard cataracts, which are common in underprivileged groups, make phacoemulsification far more difficult, time-consuming and expensive and prone to complications **(Riaz Y et al., 2013)**.

In the patient populations studied in this research, when high volume surgery is a priority, MSICS may be a better option due to its lower cost. MSICS stands for manual small incision cataract surgery. As a popular technique, it combines all the benefits of phacoemulsification with the added benefits of greater applicability, safety, ease of learning, low cost, and machine independence, making it ideal for high-volume surgeries. The landmark step in development of

this surgery has been the concept of scleral-pocket tunnel introduced by Dr. Richard Kratz **(Gogate P et al., 2010)**. This study aims to find out that whether MSICS is comparable, better, or worse in terms of postoperative visual outcome, corneal edema and Descemet's membrane detachment (DMD) in cataracts as compared to phacoemulsification.

## Patients and Methods

**Study subjects:** A Prospective, Comparative, Randomized and Interventional study of 100 eyes complaining of senile cataract of variable density, attended the outpatient clinic of ophthalmology department, Qena university hospital in the period between May 2020 to May 2021. The age group between 50-70 years old, of both sexes. Patients were divided into two groups: Group A: 50 eyes have had phacoemulsification. Group B: 50 eyes have had manual small incision cataract surgery. Randomization was achieved by: All subjects were given numbers and no names used. As the surgeries were conducted by the surgeon another supervisor records results post-operative.

**Inclusion criteria:** The study has been enrolled patients with age-related cataract. Age between 50 and 70 years old. No limitations towards sex. Visual acuity 6/60 or worse.

**Exclusion criteria:** Patients with glaucoma, corneal pathology, inflammatory eye disease, previous ocular surgery or trauma, and cases with any surgical complications. Cataracts with nuclear sclerosis more than grade IV. Patients who were unable to attend the follow-up visits or if they were unable to give informed consent.

**Ethical considerations:** Informed consent from all patients was taken. The research was done only by scientifically qualified personnel. All patient data was confidentially kept as data entry files had no names, only ID numbers of the participants. The proposal was reviewed by the Ethical Committee of Faculty of Medicine. Approval code no. 101 Date Nov. 2022. The surgeries were done only by two scientifically qualified surgeons, one surgeon for each group.

**Study examination:** All patients were subjected to: Full ophthalmological examination including

Visual Acuity (VA): The VA has been determined by using Snellen's chart without and with correction after taking the refraction to obtain the best corrected visual acuity (BCDVA). Then to be changed to Log Mar. Slit lamp examination: Careful anterior segment examination has been done to examine the eye then determine type of cataract. Applanation tonometer: For intraocular pressure measurements (IOP). Fundus examination: Fundus examinations have been done with non-contact Volk 90D or direct or indirect Ophthalmoscope to evaluate the fundus if seen. Scan ultrasonography has been done if fundus not seen. Anterior Segment Optical Coherence Tomography (AS-OCT) to assess corneal thickness and ant. Chamber depth.

### *Study procedure*

**Intraoperative Procedure.** All cases were done under Ocular local anesthesia administered by peribulbar injection of xylocaine and hyaluronidase. Preoperatively, the pupils were dilated. All surgeries were done through a superior or supra temporal incision. In SICS, a superior rectus bridge suture was made. Then conjunctival periotomy was done. The incision size of 7 mm wide in sclera 2mm posterior to the limbus and a corneoscleral tunnel was made with the use of a crescent blade and a keratome 3.2 mm. prolapse of the nucleus to the Ant. Chamber then delivery it through the corneoscleral tunnel either by visco expression, using of irrigating victus or using of a " fishhook " made from insulin syringe needle. At the end of surgery, no sutures were used to close scleral while conjunctival periotomy was closed using 8/0 vicryl sutures and a subconjunctival injection of Gentamycin and Dexamethasone was given in all cases. While in phacoemulsification, clear corneal incision 2.8 mm wide. Anterior continuous curvilinear capsulorrhexis was done in

all cases and in mature white cataracts Trypan Blue was used to stain capsule before rhexis. A "divide and conquer" technique was used in all cases of phacoemulsification. At the end of surgery, a subconjunctival injection of Gentamycin and Dexamethasone was given in all cases. Antibiotic eye drops were instilled before patching the eye for all cases from both groups.

**Follow up:** Patients were evaluated by complete ophthalmic examination on postoperative days 1, 3, 7 and 14 days. Then every 2 weeks for at least 3 months. Snellen uncorrected distant visual acuity (UCDVA) and best corrected distant visual acuity (BCDVA), slit-lamp evaluation, fundus evaluation, refraction and IOP have been measured in each visit. AS-OCT has been done at 1<sup>st</sup> and 14<sup>th</sup> day of follow-up. For Measurements of corneal thickness (CT) and evaluation of Descemet's membrane detachment if present at site of wound in MSICS and clear corneal main incision in Phacoemulsification with a high-speed AS-OCT (Heidelberg - SPECTRALIS<sup>®</sup> Anterior Segment Module, Heidelberg, Germany). Measuring Central Corneal thickness and Descemet's membrane detachment were done.

### *Statistical analysis*

The data were tested for normality using the Kolmogorov-Smirnov test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by number and percent (N, %), where continuous variables described by mean and standard deviation (Mean, SD). Chi-square test and Fisher exact test used to compare between categorical variables where compare between continuous variables by t-test. A two-tailed  $p < 0.05$  was considered statistically significant. All analyses were performed with the IBM SPSS 26.0 software.

### **Results**

The age in Phaco group ranged from 50 to 70 years with mean  $\pm$ SD was  $61.74 \pm 5.97$  years while the in SICS group the age

ranged from 50 to 70 years with mean  $\pm$ SD was  $62.28 \pm 5.81$  years with no statistically significant difference between the two

groups ( $p=0.651$ ). 56% were males and 44% were females in Phaco. group while in SICS group, 50% were males and 50% were females with no statistically significant difference between the two groups regarding sex ( $p=0.548$ ) The degree of nuclear sclerosis in Phaco group was Grade II in 13 eyes (26%), Grade III 12 eyes (24%) and Grade IV in 25 eyes (50%). While in MSICS group it was 5

eyes (10%) Grade II, 12 eyes (24%) Grade III and 33 eyes (66%) Grade IV nuclear sclerosis with statistically significant difference between two groups in Grade II nuclear sclerosis ( $p=0.037$ ) and no statistical difference in Grade III and IV nuclear sclerosis between two groups ( $p=1.000$  in grade III,  $p=0.105$  in grade IV) as presented in (Table 1.)

**Table 1: Baseline characteristics among the two studied groups**

	Phaco group (n=50)		SICS group (n=50)		P. value
	No.	%	No.	%	
<b>Sex</b>					
Male	28	56.0	25	50.0	0.548
Female	22	44.0	25	50.0	
<b>Age</b>					
Range	50 - 70		50 - 70		0.648
Mean±SD	61.74 ± 5.97		62.28 ± 5.81		
<b>Degree of nuclear sclerosis</b>					
Grade II	13	26.0%	5	10.0%	0.037*
Grade III	12	24.0%	12	24.0%	1.000
Grade IV	25	50.0%	33	66.0%	0.105

**P. value:** Comparison between group A & B

In Phaco. group showed that 46% cases had BCDVA of (0.00- 0.25), 42% had BCDVA of (0.26- 0.50), 6% had BCDVA of (0.51- 0.75), 4% had BCDVA of (0.76- 1.00) and 2% had BCDVA of (1.01- 1.25) while in SICS group, 40% cases had BCDVA of (0.00- 0.25), 38% had BCDVA of (0.26- 0.50), 12% had BCDVA of (0.51- 0.75), 10% had BCDVA of (0.76- 1.00) and none of cases had BCDVA of (1.01- 1.25). There were no significant differences between the two groups regarding BCDVA at 3 months ( $p>0.05$ ) as presented in (Table2).

SICS group had significant decrease in central corneal thickness (CCT) compared to Phaco group at first day postoperative

( $561.69\pm 40.35$  Vs  $686.64\pm 61.3$ ,  $p<0.001$ ) while there were no significant differences between the two groups regarding CCT preoperative and at 2nd week ( $p>0.05$ ). In both groups, there were significant decrease in CCT 2nd week compared to preoperative and 1st day postoperative ( $p<0.001$  in both groups) as presented in (Table 3).

The mean SIA at 3 months in Phaco group and SICS group were  $-0.84\pm 0.18$  and  $-1.92\pm 0.63$  respectively. SIA at 3 months was significantly elevated in SICS group compared to Phaco. Group ( $p<0.001$ ). The mean SE at 3 months was  $-1.42\pm 0.07$  in Phaco group and  $-1.96\pm 0.3$  in MSICS group with no significance difference between two groups ( $p=0.211$ ) as presented in (Table 4).

**Table 2: Comparison between the studied groups regarding BCDVA 3 months**

	Phaco group (n=50)		SICS group (n=50)		P. value
	No.	%	No.	%	
<b>BCDVA 3 months</b>					
0.00-0.25	23	46.0	20	40.0	0.545
0.26-0.50	21	42.0	19	38.0	0.683
0.51-0.75	3	6.0	6	12.0	0.487
0.76-1.00	2	4.0	5	10.0	0.436
1.01-1.25	1	2.0	0	0.0	1.000

P. value: Comparison between group A & B

**Table 3: Comparison between the studied groups regarding central corneal thickness(CCT) at different follow-up periods**

	Phaco group (n=50)	SICS group (n=50)	P. value <sup>1</sup>
<b>Cct preoperative</b>			
Range	516.13 – 540.64	513.13 – 540.46	0.062
Mean±SD	523.86±7.32	521.02±7.69	
<b>Cct 1<sup>st</sup> day</b>			
Range	543.25 - 846.72	521.39 - 756.35	<0.001**
Mean±SD	686.64±61.3	561.69±40.35	
<b>Cct 2<sup>nd</sup> week</b>			
Range	513.46 – 615.43	512.46 - 551.43	0.167
Mean±SD	537.43±20.1	533.19±7.68	
<b>P. value<sup>2</sup></b>	<0.001**	<0.001**	

P. value<sup>1</sup>: Comparison between group A & B

P. value<sup>2</sup>: Comparison between 1<sup>st</sup> day and 2<sup>nd</sup> week for each group.

Descemet's membrane detachment at first day postoperative was found in 28% cases in Phaco. Group and 20% cases in SICS group while after 2<sup>nd</sup> week, it was found in 26% cases in Phaco. Group and 20% cases in SICS group. There were no significant differences between the two groups

regarding Descemet's membrane detachment at first day postoperative and at 2<sup>nd</sup> week ( $p>0.05$ ) as presented in (Table 5). Resolution of all Descemet's membrane detachment occurred by 3 months postoperative.

**Table 4: Comparison between the studied groups regarding surgically induced astigmatism(SIA) and refractive outcome in spherical equivalent (SE)at 3 months**

	Phaco group (n=50)	SICS group (n=50)	P. value
<b>SIA 3 months</b>			
Range	-1.36 - -0.45	-3.25 - -0.5	<0.001**
Mean±SD	-0.84±0.18	-1.92±0.63	
<b>SE 3 months</b>			
Range	-1.68 - -1.23	-2.63 - -1.25	0.211
Mean±SD	-1.42±0.07	-1.96±0.3	

P. value: Comparison between group A & B

**Table 5: Comparison between the studied groups regarding Descemet's membrane detachment at different follow-up periods**

	Phaco group (n=50)		SICS group (n=50)		P. value
	No.	%	No.	%	
<b>Descemet's membrane detachment 1st day</b>	14	28.0	10	20.0	0.349
<b>Descemet's membrane detachment 2nd week</b>	13	26.0	10	20.0	0.476

**P. value:** Comparison between group A & B

### Discussion

MSICS is comparable to phacoemulsification for the treatment cataracts. It is recommended as an alternative to phacoemulsification wherever the required equipment and experience are not available. According to (Enany HA. 2018) a hard brown cataract is a well-known risk factor for intraoperative complications during phacoemulsification while in MSICS it's much less liable to complications. Cataract surgeries has an increasing popularity nowadays as the sole treatment for cataracts so, postoperative complications of cataract surgeries are widely reported one of the most common complications is postoperative reports of corneal Descemet membrane detachment that in some studies ranged from 36.7% to 82% (Xia Y et al., 2009). In the past, the grading standards for the detachment were created by Liu Zuguo in (1990) That is, detachments were divided into five grades: the detachment range less than 1/8 cornea was local, the detachment range greater than 1/8 but less than 1/4 cornea was mild, the detachment range greater than 1/4 but less than 1/2 was moderate, the detachment range equal to or greater than 1/2 was severe, and the complete detachment was full. Due to limitation of the equipment at that time, the previous classification was based on rough estimation of the extent of corneal edema and the range of detachment of Descemet's membrane (DM). Therefore, it is difficult to determine the precise location of DM detachment. In contrast, the current AS-OCT can accurately distinguish the

location and the extent of the DM detachment and suggest a close relationship between the detachment and the incision of DM. Ping Guo et al., (2018) classified DM detachments based on AS-OCT findings to simple: confined to incisional area, symmetrical:  $>1/4$  of cornea and  $<1/2$  and complete:  $>1/2$  of cornea. In our study most of detachments were simple confined to main incisional area and the condition could be self-healing without any intervention. However, some is complicated with folding, curly, or complete detachment of the DM causing refractory corneal stromal edema or even corneal endothelial dysfunction with severe decrease of visual acuity.

The rate of DM detachment in our study was lower compared to previously mentioned studies, with AS-OCT showing DM detachments in (14 cases 28% of eyes in the phaco group) and (10 cases 20% of eyes in MSICS group) in day 1 post-operative with no statistical difference between two groups (p.value = 0.349) and continued after 2 weeks post-operative (13 cases 26% of phacoemulsification group) and (10 cases 20% of MSICS group). (Table5) Most of which were simple detachment confined to incision site with spontaneous resolution whoever one case of MSICS group had moderate Detachment  $>1/4$  of cornea and  $<1/2$  that was responsible for sever edema that resolved within two weeks with the help of intracameral air injection in 1st postoperative day after detecting DM detachment with AS-OCT.

Another common complication of cataract surgery is postoperative corneal edema which is more with phacoemulsification group due to energy used in emulsifying the nucleus and its effect on endothelial cell counts. In our study, MSICS group was better in terms of corneal edema than phacoemulsification group in a larger proportion of patients' 1<sup>st</sup> day postoperatively. **Venkatesh et al.,(2010)** showed that the MSICS group had less corneal edema than the phacoemulsification group on the first postoperative day in cases with white cataract.

As indicator for corneal edema and its follow up central corneal thickness was recorded in this study in 1<sup>st</sup> day postoperative and after 2 weeks and it was as follows: the mean difference in central corneal thickness at 1<sup>st</sup> day post operative was statistically different (p. value < 0.001), while in 2<sup>nd</sup> week was not statistically significant (p. value = 0.167). In addition, the mean coefficient of variation and the mean±SD between both groups were not statistically significant.(Table 3)

As regard visual outcome and rehabilitation between two groups in our study, at 3 months, (44 patients/88%) of phacoemulsification group had a BCDVA of 6/12 or better as compared to (38 patients / 78%) in MSICS (Table 2). The mean surgically induced astigmatism (SIA) at 3 months was -0.84 +/- 0.18 dioptres in the phaco group and -1.92 +/- 0.63 dioptres in MSICS group. The difference between the two groups was significant (p. value < 0.001) (BCD4), while the mean spherical equivalent (SE) of the refractive outcome was -1.42 +/- 0.07 in Phaco group and -1.96 +/- 0.3 in MSICS group with no significant difference between two groups (p.value = 0.211)which suggests comparable results between two groups in terms of visual outcome (Table 4).

**(Haripriya et al.,2012)** after phacoemulsification and manual MSICS by surgeons who are well-versed in both methods, report excellent visual outcomes with low complication rates.

**Venkatesh et al.,(2010)**Both surgical procedures had good visual results, with both groups having a corrected distance acuity of at least 6/18 two months after surgery (92.5 vs. 85 percent, P=0.36). Uncorrected distance acuity of at least 6/18 2 months after surgery was attained in 85 and 75 percent of patients, respectively, in the current study. **Gogate et al.,(2005)** Although phacoemulsification generates improved uncorrected acuity in a wider group of patients at 6 weeks, both phacoemulsification and minor incision procedures were found to be safe and effective for visual rehabilitation of cataract patients.

**El-Sayed et al.,(2015)** Both phacoemulsification and MSICS were found to produce outstanding visual results with low complication rates. MSICS is less technologically reliant. As a result, it is less expensive and more appropriate for treating severe cataracts in developing nations.

Surgical speed and efficiency are of paramount importance in developing nations having a high burden of cataract. In the present study, MSICS proved to be a much faster (10.8±2.9 versus 13.2±2.6min) surgical technique than phacoemulsification in patients with uveitis.

In a randomized controlled trial by **Cook et al. (2012)**,In a study of 200 patients in the African subcontinent, there was no difference between phacoemulsification and MSICS in terms of intraocular problems and uncorrected visual acuity on the first postoperative day. Another prospective randomised trial was conducted.

MSICS was significantly faster (8.8±3.4min) as compared to phacoemulsification (12.2±4.6min) for advanced white cataracts (**Venkatesh R.et al. 2010**).In Nepal, a study by **Ruit et al.,(2007)**found for advanced age-related cataracts, phacoemulsification and manual MSICS resulted in excellent visual results and low complication rates. When compared to phacoemulsification, manual MSICS took much less time and cost.

## Conclusion

The goal of this study was to compare post-operative complications especially incidence of Descemet's membrane separation and corneal edema in phacoemulsification and MSICS measured by Anterior Segment Optical Coherence Tomography (AS-OCT) and visual rehabilitation between both methods. From this study, we found that there are no statistically significant differences between the two techniques according to Descemet's membrane detachment. However, in terms of corneal edema there was a statistical difference in central corneal thickness between two techniques especially in early post-operative period with the phacoemulsification technique group being more reliable to moderate to severe corneal edema than MSICS group, however by three months period post-operative the central corneal thickness between two groups was statistically insignificant. As for visual outcome we found that visual rehabilitation is faster with MSICS group due to fore-mentioned corneal edema in early post-operative period while in three months period post-operative we found that the BCDVA between two groups is statistically insignificant with the MSICS group being higher in surgically induced astigmatism (SIA) than phacoemulsification group. We concluded that Phacoemulsification and MSICS achieve comparable and excellent visual outcomes in dealing with cataract, with lower complication rate, earlier postoperative visual rehabilitation, terms of cost and independence from technology in MSICS.

### Limitations

Limitations of our study are that endothelial cell counts weren't compared between both the techniques because of unavailability of necessary equipment. Another limitation that only one technique of MSICS was used and other techniques could yield different results

### Recommendations

We recommend further studies to compare phacoemulsification and MSICS in terms of intra

operative complications and learning difficulties between two techniques.

### References

- **Blumenthal M, Ashkenazi IN, Asia E, Cahane M. (1992)** Ophthalmic Surgery, ;23(10):699-701.
- **Bourne RR, Minassian DC, Dart JK, Rosen P, Kaushal S, Wingate N (2004).** Effect of cataract surgery on the corneal endothelium: modern phacoemulsification compared with extra capsular cataract surgery. Ophthalmic, 111:679-685.
- **El-Sayed SH, El-Sobky HM, Badawy NM, El-Shafy EA. (2015)** Phacoemulsification versus manual small incision cataract surgery for treatment of cataract. Menoufia Medical Journal, 28:191–196.
- **Enany HA.(2018)** Phacoemulsification versus manual small incision cataract surgery in hard nuclear cataracts. Delta Journal of Ophthalmology,19: 92-98.
- **Gogate P, Ambardekar P, Kulkarni S, Deshpande R, Joshi S, Deshpande M (2010).** Comparison of endothelial cell loss after cataract surgery: phacoemulsification Vs manual small incision cataract surgery: six-week results of a randomized control trial. Journal of Cataract & Refractive Surgery,36(2):247-253.
- **Gogate P, Kulkarni SR, Krishnaiah S, Deshpande RD, Joshi SA, Palimkar A et al. (2005)** Safety and efficacy of phacoemulsification compared with manual small-incision cataract surgery by a randomized controlled trial: six-week results. Ophthalmology, 112:869–874.
- **Haripriya A, Chang DF, Reena M, Shekhar M.(2012)** Complication rates of phacoemulsification and manual small-incision cataract surgery at Aravind Eye

- Hospital. *Journal of Cataract & Refractive Surgery*, 38:1360–1369.
- **Liu Z, Peng HLM, Lin Z.(1990)** Cataract postoperative removal of corneal Descemet membrane (report of 11 cases) *Journal of Practical Ophthalmology*, 6:17–21.
  - **Ping Guo, Yujin P, Yuan Z, Sean T, Yingting Z, Minge L et al. (2018)** Study on the classification of Descemet membrane detachment after cataract surgery with AS-OCT. *International Journal of Medical Sciences*, 15(11): 1092–1097.
  - **Riaz Y, de Silva SR, Evans JR. (2013 Oct 10)** Manual small incision cataract surgery (MSICS) with posterior chamber intraocular lens versus phacoemulsification with posterior chamber intraocular lens for age-related cataract. *The Cochrane Database of Systematic Reviews*, (10):CD008813. doi: 10.1002/14651858.CD008813.pub2. PMID: 24114262.
  - **Ruit S, Paudyal G, Gurung R, Tabin G, Moran D, Brian G. (2000)** An innovation in developing world cataract surgery: suture less extracapsular cataract extraction with intraocular lens implantation. *Clinical & Experimental Ophthalmology*, 28(4):274-279.
  - **Ruit S, Tabin G, Chang D, Bajracharya L, C Kline D, Richeimer W. (2007).** A prospective randomized clinical trial of phacoemulsification vs manual suture less small-incision cataract surgery in Nepal. *American Journal of Ophthalmology*, 143:32-38.
  - **Ruit S, Tabin GC, Nissman SA, Paudyal G, Gurung R. (1999) Oct.** Low-cost high-volume extracapsular cataract extraction with posterior chamber intraocular lens implantation in Nepal. *Ophthalmology*,106(10):1887-1892. doi: 10.1016/S0161-6420(99)90397-4. PMID: 10519581.
  - **Venkatesh R, Tan CS, Sengupta S, Ravindran RD, Krishnan KT, Chang DF. (2010)** Phacoemulsification versus manual small-incision cataract surgery for white cataract. *Journal Cataract Refractive Surgery*, 36(11):1849–1854.
  - **Xia Y, Liu X, Luo L, Zeng Y, Cai X, Zeng M et al. (2009)** Early changes in clear cornea incision after phacoemulsification: an anterior segment optical coherence tomography study. *Acta Ophthalmology*, 87(7):764-768.