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Original Article

Ophthalmology Section

Learning Curve of Ophthalmic Postgraduate Students during Training in Manual Small Incision Cataract Surgery (MSICS): A Cross-sectional Study

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ABSTRACT

Introduction: Ophthalmology residency programs play a critical role in training surgeons to perform cataract surgery. A fundamental component for developing competency in cataract surgery is undergoing a structured surgical training program. There is an inverse relationship between the number of surgeries performed by a resident and adverse surgical outcomes.

Aim: To assess the learning curve of Manual Small Incision Cataract Surgery (MSICS) performed by postgraduate students during their residency tenure by estimating the difficulties encountered and intraoperative and postoperative complications during surgical training.

Materials and Methods: A hospital-based cross-sectional study was conducted in the Department of Ophthalmology, Hassan Institute of Medical Sciences (HIMS) Teaching Hospital, Hassan, Karnataka, India, from July 1st 2020 to January 1st 2023. Study included 249 patients undergoing MSICS by three postgraduates, who enrolled in the Master of Surgery (MS) Ophthalmology course and received hands-on training in a wet lab were selected. They performed MSICS in a stepwise manner under the supervision of a trained ophthalmologist. Surgeries were recorded and discussed in surgical audits, and intraoperative and postoperative complications were analysed. The collected data was statistically analysed using descriptive statistics such as frequency and percentage.

Results: A total of 249 patients, including 135 (54.2%) females and 114 (45.7%) males, with a mean age of 68.4 years, were included in the study. The majority (47%) of cases were senile immature nuclear sclerotic cataracts grade 3-4. Difficulties encountered during the surgeries were tunnel formation (24.6%), capsulotomy (4.5%), nucleus delivery (21.5%), cortical wash (34.3%), and Intraocular Lens (IOL) insertion (14.8%). Intraoperative complications observed were premature entry (46.3%), roof tear (16.1%), Descemet's membrane detachment (7.3%), iridodialysis (7.3%) and Posterior Capsular Rent (PCR) (22.1%). Postoperative complications included wound gaping (0.4%), anterior chamber reaction (10.8%), corneal oedema (25.4%), striate keratopathy (58%) and raised intraocular pressure (5.1%).

Conclusion: The most common difficulty encountered during the first year of residency was tunnel formation, while the most common difficulty encountered during the second and third years was cortical wash. The most common intraoperative complication was premature entry, and the most common postoperative complication was striate keratopathy. Stepwise learning by the resident under continuous monitoring by a consultant lowers complications and gives confidence to postgraduate students.

Keywords: Manual small incision cataract surgery, Postgraduate residency programme, Resident curriculum design, Surgical training for postgraduates

INTRODUCTION

The use of MSICS has been rapidly growing in the developing world due to its lower costs in terms of capital equipment investment, equipment maintenance, and consumables per procedure [1-3]. MSICS is a quick procedure with excellent visual outcomes and low complication rates [1-3]. It is particularly useful in eye camps and high volume cataract surgery centres [4]. MSICS is universally applicable and can be performed for all grades of cataract. However, cataract surgery, like any other surgery, carries a risk of complications. The likelihood of complications decreases with each successive case, making it crucial to understand the different milestones in the learning curve for training MSICS surgeons [3].

With the increasing popularity of MSICS, effective surgical training in residency programs in developing countries requires an understanding of the learning curve for this technique among the residents. Identifying preoperative, intraoperative, and postoperative events and stratifying them based on the level of resident training can help identify the areas for curriculum revision [2].

Despite significant progress in cataract care worldwide, there remains a significant disparity in the cataract burden, with developing countries bearing the largest share. Therefore, there is a need to increase the number of competent training centres and well-trained ophthalmologists in these countries. Analysing the surgical learning curve of residents is essential for designing effective resident surgical programs. The present study was aimed to assess the learning curve of MSICS performed by Postgraduate (PG) students during their residency tenure by estimating intraoperative and postoperative complications and difficulties encountered during surgical training.

MATERIALS AND METHODS

A hospital-based cross-sectional study was conducted conducted in the Department of Ophthalmology, HIMS Teaching Hospital, Hassan, Karnataka, India, from July 1st 2020 to January 1st 2023, by three postgraduates enrolled in the MS Ophthalmology course and received 30 months of training. Permission was obtained from the Institutional Ethics Committee (IEC/HIMS/RR193/10-02-2020).

Sample size calculation: The sample size calculation for patients (n) was performed using the formula:

$$N=(Z^2\times p\times q)/\delta^2$$

where Z=1.96, p=0.17 (prevalence of cataract cases eligible for treatment by postgraduates), q=1-p=0.83, and δ=allowable error (%)=5%. The calculated sample size was 216; however, the study included 249 patients to account for potential attrition.

Inclusion criteria: Patients aged over 45 years, diagnosed with senile cataract according to Lens Opacities Classification System (LOCS) classification [5], and operated on by postgraduates were included in the study.

Exclusion criteria: Patients with presenile cataract, traumatic cataract, pediatric cataract, complicated cataract (such as lens-induced glaucoma, displaced lens, non-dilating pupil), pre-existing glaucoma, and monocular patients were operated on by consultant ophthalmologists were excluded from the study.

Study Procedure

A total of 249 patients underwent cataract surgery under the supervision of resident postgraduates. The aims and objectives of the study were explained to the subjects, and informed consent was obtained. During their first year, all residents received training on surgical anatomy of the eye, basic principles of microsurgery, and a stepwise approach to surgery. They attended lectures and live demonstrations by senior surgeons, and received hands-on training in the wet lab. Standardised surgical techniques and manoeuvres were taught to all residents.

The MSICS technique used in the study involved several steps [4]: peribulbar block anaesthesia, application of a superior rectus bridle suture, creation of a fornix-based conjunctival flap, making a superior 6-7 mm scleral incision and a sclerocorneal tunnel, performing a paracentesis, using capsular stain (0.06% trypan blue), performing a large capsulorrhexis, entering the anterior chamber through the sclerocorneal tunnel with a keratome. Carrying out hydrodissection and delineation to prolapse the nucleus into the anterior chamber, using a Sinskey hook to extract the nucleus, aspirating cortical and epinuclear remnants with a Simcoe cannula, placing a 6 mm polymethyl methacrylate IOL inside the capsular bag, and hydrating the wound and paracentesis to form the anterior chamber.

The MSICS procedures were performed by the three residents under the supervision of senior surgeons. The surgeries were recorded simultaneously via Closed Circuit Television (CCTV). Any difficulties or intraoperative complications encountered were effectively managed with the assistance of senior surgeons. Postoperative complications were noted and managed appropriately. On average, each postgraduate operated on 83 patients out of the total 249. The performance of the residents was continually assessed by an experienced cataract consultant with a Master's degree in Ophthalmology and a minimum of 10 years of surgical and teaching experience. The residents maintained logbooks that documented patient profiles, preoperative, intraoperative and postoperative events. As part of their training, the residents attended monthly quality assurance meetings where surgical audits were conducted using video recordings of the surgeries. The complication rates were reviewed by senior surgeons, and difficulties and complications encountered during the intraoperative period were discussed and surgical outcomes analysed. Postoperative Best Corrected Visual Acuity (BCVA) was measured on day one, one week, three weeks, and six weeks post-surgery.

STATISTICAL ANALYSIS

Descriptive analysis of resident and patient level data was conducted. The data was entered into Microsoft Excel and analysed using Statistical package for the Social Sciences (SPSS) software version 22.0. Descriptive statistical analysis was performed, and the results were expressed in frequencies and percentages.

RESULTS

During their residency period, three residents performed MSICS procedures on 249 patients under the supervision of a senior surgeon. The patients, consisting of 135 (54.2%) females and 114 (45.7%) males with a mean age of 68.4 years, underwent cataract surgery. The right eye was operated on in 149 cases, while the left eye was operated on in 100 cases. The median preoperative Uncorrected Visual Acuity (UCVA) was 6/60. The majority (47%) of cases had senile immature nuclear sclerotic cataracts grade 3-4, as per the LOCS classification [Table/Fig-1].

Difficulties encountered	n (%)
Tunnel formation	81 (24.6)
Capsulotomy	15 (4.5)
Nucleus delivery	71 (21.5)
Cortical wash	113 (34.3)
IOL insertion	49 (14.8)
Total, n (%)	329 (100)

[Table/Fig-1]: Difficulties encountered.

Difficulties encountered during the surgeries included tunnel formation (24.6%), capsulotomy (4.5%), nucleus delivery (21.5%), cortical wash (34.3%) and IOL insertion (14.8%). Tunnel formation was the most common difficulty initially, while cortical wash became more common later on. Intraoperative complications included premature entry (46.3%), roof tear (16.1%), Descemet's Membrane (DM) detachment (7.3%), iridodialysis (7.3%), and PCR (22.1%) [Table/Fig-2]. Premature entry and roof tear were more frequent during the initial days of training.

Intraoperative complications	n (%)
Premature entry	44 (46.3)
Roof tear	16 (16.1)
Descemet's membrane detachment	7 (7.3)
Iridodialysis	7 (7.3)
Posterior capsule rent	21 (22.1)
Total, n (%)	95 (100)

[Table/Fig-2]: Intraoperative complications.

Postoperative complications included wound gaping (0.4%), anterior chamber reaction (10.8%), corneal oedema (25.4%), striate keratopathy (58%) and elevated intraocular pressure (5.1%) [Table/Fig-3].

Postoperative complications	n (%)
Wound gaping	1 (0.4)
Anterior chamber reaction	23 (10.8)
Corneal oedema	54 (25.4)
Striate keratopathy	123 (58)
Raised intraocular pressure	11 (5.1)
Total, n (%)	212 (100)

[Table/Fig-3]: Postoperative complications.

Difficulties and complications were highest in the first three months of training and decreased as training progressed. The first 60

cases required the most supervision. Resurgeries were performed in seven cases, including anterior chamber formation (one case), iris claw implantation (two cases), and posterior chamber IOL implantation (four cases). The reoperation rate in the present study was 0.03%, with PCR (22%) and wound leak (1%) being the main reasons for reoperation. At the six-week follow-up, BCVA was 6/6-6/24 in 192 (77%) cases, less than 6/24-6/60 in 50 (20%) cases, and less than 6/60 in 7 (3%) cases [Table/Fig-4].

Visual acuity (Snellen chart)	POD 1 n (%)	1 week after surgery n (%)	3 weeks after surgery n (%)	6 weeks after surgery n (%)
6/6-6/24	174 (70)	186 (75)	192 (77)	192 (77)
<6/24-6/60	62 (25)	50 (20)	50 (20)	50 (20)
<6/60	13 (5)	13 (5)	7 (3)	7 (3)

[Table/Fig-4]: Postoperative Best Corrected Visual Acuity (BCVA).
POD: Postoperative day

DISCUSSION

Cataract surgery is a crucial skill acquired during residency training. The present hospital-based study on resident cataract surgery performance reveals that as resident surgeons gain experience with MSICS, the risks of intraoperative complications, first-day postoperative complications, and reoperations significantly decrease. The mean age of the subjects in the current study (68.4 years) is similar to Gupta S et al., where the average mean age was 60 years [1]. The study participants were predominantly females (54%), which aligns with studies by Megbelayin EO et al., where females also constituted a significant majority (57%) [4].

Adequate surgical training led to a reduction in first-day postoperative complication rates. The most common intraoperative complication observed was premature entry (46.3%), in contrast to Clarke C et al., where the most common intraoperative complications where vitreous loss (6.7%) and posterior capsule tear (7.0%) were the most common intraoperative complications [2]. The incidence of PCR in the present study (22.1%) differs from the study by Megbelayin EO et al., where PCR accounted for almost half (42%) of all complications [4]. The rate of reoperations (0.03%) in the present study was similar to that reported by Gupta S et al., (1.17%), with PCR and wound leak being the main reasons for reoperation [1].

The results of the present study are consistent with previous literature, showing that the implementation of a structured surgical curriculum leads to a statistically significant reduction in sentinel event complications [6-10].

Regarding BCVA at the six-week mark, the current study found that it was 6/6-6/24 in 77% of patients (192 cases), less than 6/24-6/60 in 50 (20%) cases, and less than 6/60 in 7 (3%) cases, which aligns with study by Megbelayin EO et al., where BCVA at the end of six weeks was 6/6-6/12 in 76.5% of the cases [4].

Patient selection is crucial in training MSICS surgeons. Ideal candidates include those with immature cortical or LOCS grade II-III nuclear sclerosis that can be shaped through the scleral tunnel [4]. Other important factors include a healthy cornea in terms of clarity, thickness, and endothelial cell count, intact zonular integrity and adequate intraoperative mydriasis. Initially, trainees should be encouraged to perform a more familiar can-opener capsulotomy while focusing on tunnel construction and geometry. The importance of removing redundant capsular tags after can-opener capsulotomy or queer rhexis margin with vannas to avoid extending a capsular marginal tear to the posterior capsule during nucleus prolapse and rotation cannot be overstated.

In India, the majority of residency programs teach MSICS, in contrast to wealthier nations like the United States where residents often learn phacoemulsification [10-12]. A structured training program in cataract surgery, following a stepwise approach under continuous monitoring by a trained ophthalmologist, not only yields surgical results but also improves the morale and confidence of the residents [4,13,14]. Surgical skill is a subjective phenomenon that depends on the inherent skill of each resident, their commitment, and surgical acumen, making generalisation difficult. Therefore, meticulous tracking of the learning curve of numerous residents during their residency periods is warranted in future studies.

Limitation(s)

The main limitation is that only three postgraduates were included in the study. The learning curve of each postgraduate is not uniform. Surgical skill depends on the inherent skill, commitment, and preparation of the postgraduate, which cannot be generalised.

CONCLUSION(S)

Based on the findings of the present study, it can be concluded that assessing the difficulties faced during surgeries and considering both intraoperative and postoperative complications will help improve the surgical skills of residents, leading to better outcomes for the patients. The results of the present study can aid in designing a structured surgical training program for residents. Such a program should include wet lab sessions, simulator practice, sufficient surgical volume, continuous supervision by a trained ophthalmic surgeon, and detailed discussions during surgical audits. This not only helps reduce surgical complications but also enables progression to phacoemulsification. Additionally, it enhances the confidence of postgraduate residents in independently performing cataract surgeries.

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