

Analysis of intraocular pressure changes following manual small incision cataract surgery in South India – An observational study

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Abstract:

Background: Cataract and glaucoma are the two common blinding diseases. Surgical management of a patient with coexisting cataract and glaucoma has been a subject of debate for decades (Greve, 1987).^{1,2} Glaucoma surgery is usually deferred until medical therapy fails to achieve target intraocular pressure.² This study aims to determine the changes in intraocular pressure following uncomplicated manual small incision cataract surgery in patients presenting to a tertiary health care institute for cataract surgery. As of date, there are no studies on IOP variation following MSICS in South Indian population. In this study, we summarise the evidence available on effects of cataract surgery on intraocular pressure.

Materials and Methods: This was a prospective observational study conducted in 100 participants aged 40 years and above who underwent uncomplicated cataract surgery in a tertiary care center in a period of 18 months. Variation in intraocular pressure were measured pre operatively and postoperative day 1 and 6th week. Results were statistically analysed ($p < 0.05$)

Results: 100 participants were included in this study. Mean age was 63.1 ± 9.6 years. The male: female ratio was 1.35: 1. Mean IOP pre operatively was 15.7 ± 2.1 mmHg; Day 1 was 18.4 ± 2.0 mmHg and 6th week was 13.6 ± 1.6 mmHg. (p value < 0.005). Mean IOP reduction at 6th week was 2.120 mmHg and statistically significant.

Conclusion: IOP measurement after an uncomplicated cataract surgery showed a rise in day 1 and a significant reduction from baseline IOP at 6th week. Postoperative reduction in IOP may influence glaucoma therapy. Long term follow-up may show further significant reduction.

Key Word: Intraocular pressure changes, manual small incision cataract surgery (MSICS)

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I. Introduction

Cataract and glaucoma are the two common blinding diseases. In developed countries, cataract surgery stands as most commonly performed surgical procedure.¹ In all situations, aim of therapy in glaucoma is to stop the progression of optic neuropathy by control of intraocular pressure (IOP). Uncomplicated cataract surgery has a variable effect on IOP depending upon the method, and the postoperative course.¹ Manual small-incision cataract surgery (MSICS) still remains as cost-effective and safe procedure for treating cataract blindness in the developing countries. MSICS shows good visual outcome in comparison to phacoemulsification.³ Friedman et al study suggests significant short term rise in IOP following phacoemulsification and posterior chamber intraocular lens (PC IOL) implantation on IOP in glaucoma patients, whereas studies relative to IOP changes in MSICS in healthy individuals remain unclear.⁴ Surgical technique, IOL positional parameters play a predictive role in IOP variation.^{1,5} Studies suggest various factors associated with cyclic IOP fluctuations after cataract surgery, including diurnal cardiac rhythms, aqueous production, and different body postures.⁵ Any change in ocular biomechanical properties after surgery can also affect the measurement of IOP.^{1,3}

Andrezej et al believed that IOP increases after surgery noted at 6- 7th hour and persists during the first day likely due to minor surgical trauma with anterior chamber inflammation and 3- 4 hours post-surgery being the most crucial period for glaucoma patients.^{6,7} Preoperative IOP or a diagnosis of glaucoma or ocular hypertension were significant risk factors for raised next-day IOP after phacoemulsification.^{2,3} The behaviour of IOP after cataract surgery in Indians remains unknown.⁸ Preoperative IOP value is considered a reliable predictor

for IOP after surgery and anatomic alterations like increase in anterior chamber depth, angle opening, and posterior capsule moving posteriorly have been reported to be the risk factors for IOP elevation. Future studies are needed to investigate magnitude of IOP change after cataract extraction.⁹ Bilak et al showed cataract surgery with IOL implantation causes significant anterior chamber deepening and a decrease of IOP in normal and glaucomatous patients whereas changes long term IOP changes remains unknown.^{7,8} As of date, there are no studies monitoring IOP variation following MSICS and in South Indian population.

II. Material And Methods

This was a prospective observational study, which was conducted at the Mahatma Gandhi Medical College and Research Institute Hospital, a rural tertiary care hospital over 18 months period from January 2021 to June 2022. About 100 participants, aged >40 years were included in this study.

Study Design: Prospective observational study

Study Location: This was a tertiary care teaching hospital based study done in Department of Ophthalmology, at Mahatma Gandhi Medical College and Research Institute Hospital, a rural tertiary care hospital.

Study Duration: January 2021 to June 2022.

Sample size: 100 patients.

Sample size calculation: The sample size was estimated on the basis of a single proportion design. The target population from which we randomly selected our sample was considered 63. We assumed that the confidence interval of 10% and confidence level of 95%. The sample size actually obtained for this study was 70 patients. We planned to include 100 patients with 4% drop out rate.

Subjects & selection method: The study population was drawn from patients who presented to Mahatma Gandhi Medical College and Research Institute Hospital with cataract from January 2021 to June 2022.

Inclusion criteria:

1. Either sex
2. Aged ≥ 30 years
3. Patients having operable cataract, Dense nuclear cataract or mature cataract as per Lens Opacities classification system III [LOCS III].

Exclusion criteria:

1. Pregnant women;
2. Patients with genetic disorders
3. Patients with previous history of angina, severe vascular disease, or other life threatening disease.
4. Patients with traumatic cataract or paediatric cataract.
5. Patient with uveitis, and history of previous glaucoma surgery, long-term topical steroid therapy and denied consent.

Procedure methodology

After obtaining ethical committee approval, patients fulfilling the inclusion criteria presenting to OPD of Ophthalmology department of MGMCRI were enrolled in the study. Patients were explained about the nature of the study and a written informed consent was obtained.

Detailed ophthalmologic examination was done which included intraocular pressure measurement by Goldmann Applanation tonometry (GAT) measurement, anterior segment examination by slit lamp biomicroscopy, pupillary reflexes, visual acuity measured with Snellen's chart and extra ocular movements. Posterior segment examination using indirect ophthalmoscope or slit lamp biomicroscopy with +90D lens was done. Proposed cataract surgery was done with adequate intraoperative care and patient was followed up and IOP was measured on the first postoperative day and 6th week following cataract surgery.

Statistical analysis

All data was entered into a Data Collection Proforma sheet (Appendix 1) and were entered into Excel (MS Excel 2011). Statistical analysis was carried out using Epi-info software (version 7.3.2.). Descriptive analyses were done, and continuous variables were presented as mean and standard deviation, while categorical variables were presented as a percentage. Independent t test was used to find out the age difference between male and female. p value < 0.05 was considered statistically significant.

III. Result

One hundred subjects (100 eyes) participated in this study. Among subjects there were 57 males (57%) and 43 females (43%). The mean age of participants was 63.13 ± 9.62 years (range 40 to 90 years). Mean age of

males and females were 61.7 ± 8.5 and 59.2 ± 9.4 respectively. Difference of age among genders was not statistically significant ($p=0.32$). Majority of the participants ($n = 52$) were within age group 41-60 years [Table 1]. [Figure 1]

Age (years)	No. of cases (n)		Total (n)	p value
	Male	Female		
41-60	26	26	52	0.59
61-70	18	9	27	0.59
>70	13	8	21	0.09
Total (%)	57 (57%)	43 (43%)	100 (100.0)	0.32

Table 1: Age-gender distribution of patients

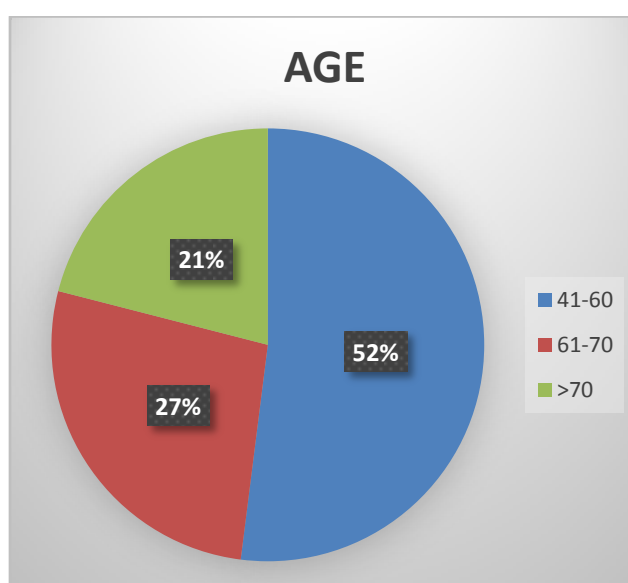


Figure 1: Gender distribution of patients.

Majority 47 (47 %) of the patients had operable cataract predominantly in left eye ($p=0.51$), 53 (53%) patients were operated for right eye ($p=0.45$). 52.6 % males were operated for left eye and 47.4 % had right eye. Laterality had no significant variation in IOP ($p=0.193$). [Table 2] [Figure 2]

Table 2: Laterality – gender distribution.

Laterality	Sex (%)		Total (%)	p value
	Male	Female		
Right	27 (47.4)	26 (60.5)	53 (53.00)	0.45
Left	30 (52.6)	17 (39.5)	47(47.00)	0.51
Total	57	43	100	0.19

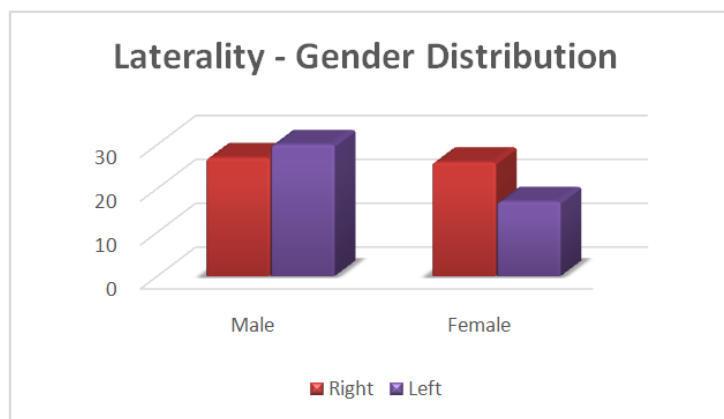


Figure 2: Bar graphical representation of Laterality – gender distribution.

INTRAOCULAR PRESSURE MEASURED AT PRESENTATION

Pre-operative IOP measurement was done at time of admission using Goldman applanation tonometry. Mean IOP was 15.76 ± 2.1 mmHg ($p=0.01$), 15.83 ± 2.2 mmHg ($p=0.03$) in left eye and right eye revealed 15.70 ± 2.0 mmHg ($p=0.01$). Table 3 shows pre-operative IOP measurement. [Figure 3]

IOP - Preoperative	Mean \pm SD	p value
Right eye	15.70 ± 2.0	0.01
Left eye	15.83 ± 2.2	0.03
Overall	15.76 ± 2.1	0.01

Table 3: IOP measurement preoperatively of patients.

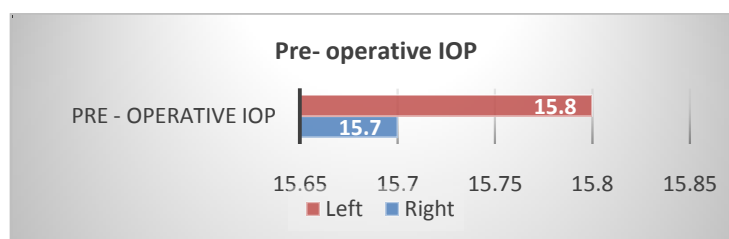


Figure 3: Bar graphical representation of Pre – operative IOP.

IOP measurement using Goldmannapplanation tonometry revealed mean IOP measurement was 15.76 ± 2.1 mmHg ($p=0.01$) preoperatively, 18.40 ± 2.1 mmHg in day 1($p=0.01$), 13.64 ± 1.7 mmHg($p=0.02$) in 6th week . Table 4 shows IOP assessment pre-operative, day1 and week 6. [Figure 4]

IOP Assessment	Mean \pm SD	p value	95% Confidence Interval	
			Lower Bound	Upper Bound
Pre-operative	15.76 ± 2.1	0.012	15.341	16.179
Day 1	18.40 ± 2.1	0.013	17.989	18.811
Week 6	13.64 ± 1.7	0.026	13.309	13.971

Table 4 : IOP assessment pre-operative, day1 and week 6.

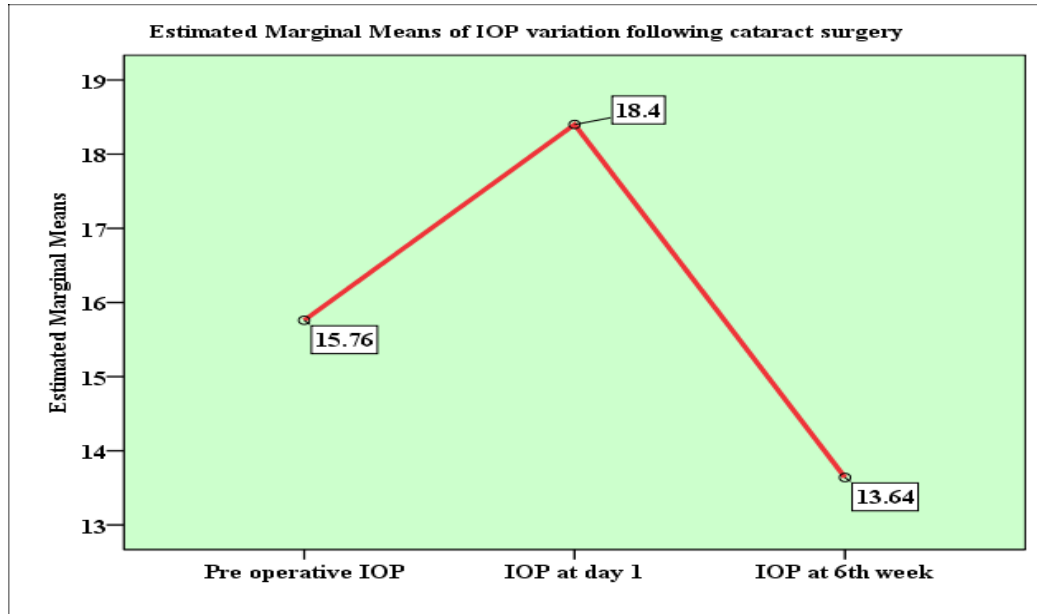


Figure 4: Graphical representation of IOP variation.

MEAN IOP COMPARISON WITH PRE OPERATIVE IOP

IOP measured 24 hours after uncomplicated cataract surgery reveals mean rise in IOP from baseline +2.6 mm Hg (p=0.01), and significant reduction from baseline - 2.120 mm Hg at 6th week(p=0.03). [Table 5] [Figure 5].

Comparison with Pre-operative IOP	Mean difference	p value	95% Confidence Interval for Difference	
			Lower Bound	Upper Bound
Day 1	2.6	0.01	2.9	2.3
6 th week	-2.1	0.03	-1.8	-2.4

Table 5 : Distribution of IOP comparison with 24 hours of uncomplicated cataract surgery.

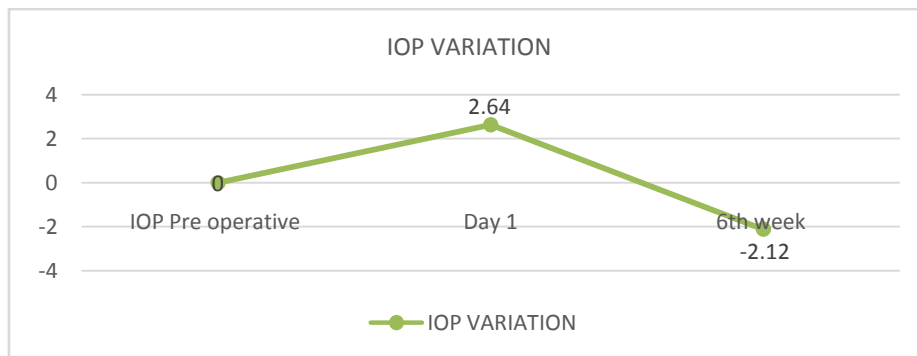


Figure 5: Graphical representation of IOP mean difference with pre-operative IOP showing a rise in day1 and reduction at 6th week.

IOP RISE 24 HOURS FOLLOWING SURGERY

IOP noted 24 hours following uncomplicated surgery revealed significant IOP rise from baseline IOP in 97 patients (p=0.01). However 3 patients did not show any significant rise from baseline IOP (p=0.41). Table 6 reveals IOP rise after 24 hours in males and females. [Figure 6].

Gender	n	No IOP rise n(p value)	IOP rise n(p value)
Male	57	1 (0.29)	56 (0.01)
Female	43	2(0.39)	41 (0.01)
Total	100	3(0.41)	97(0.01)

Table 6: IOP rise after 24 hours of uncomplicated cataract surgery

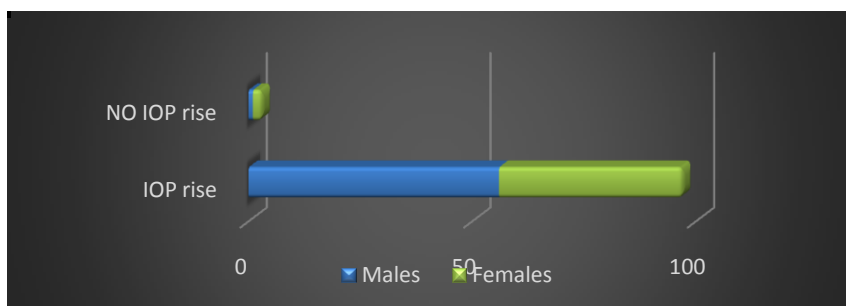


Figure 6 Bar graph representation IOP rise after 24 hours of uncomplicated cataract surgery – Gender wise.

MEAN IOP COMPARISON WITH 6th week IOP

IOP measured with GoldmannApplanation tonometry on 6th week revealed significant mean difference of -2.120 mmHg with pre-operative IOP(p=0.032) and -4.76 mmHg with day 1 (p=0.01). [Table 7]

Comparison with 6 th week IOP measurement	Mean difference	p value	95% Confidence Interval for Difference	
			Lower Bound	Upper Bound
Pre -operative	-2.120	0.032	-2.412	-1.828
Day 1	-4.760	0.011	-5.116	-4.404

Table 7 Comparison of IOP variation with 6th week IOP.

IOP REDUCTION IN 6TH WEEK FOLLOWING SURGERY

91 patients showed IOP reduction in 6th week from baseline IOP following uncomplicated cataract surgery, whereas 9 patients showed no such reduction of IOP from baseline at 6th week. Reduction was statistically significant (p=0.01), whereas comparison of IOP reduction among gender was not statistically significant..such significance of (p=0.42). Table 8 reveals IOP reduction at 6th week following cataract surgery. [Figure 7]

Gender	n	No reduction n(p value)	Reduction n(p value)
Male	57	4 (0.25)	53 (0.02)
Female	43	5(0.33)	38 (0.03)
Total	100	9(0.42)	91(0.01)

Table 8: IOP reduction at 6th week following cataract surgery

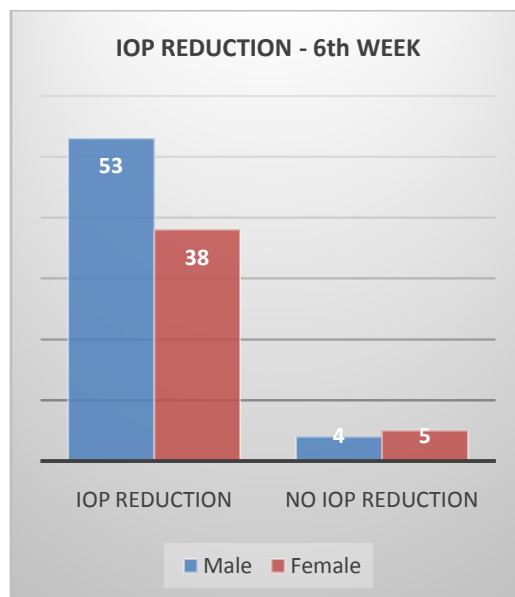


Figure 7 Bar graph representation IOP reduction at 6th week of uncomplicated cataract surgery – Gender wise.

IV. Discussion

Studies related to IOP changes following uncomplicated Manual small-incision cataract surgery (MSICS) have shown significant IOP variation. Our study revealed a significant IOP reduction at 6th week following uncomplicated MSICS. Many theories have been proposed to explain the increase in IOP in early postoperative period. The factors include blockage of trabecular meshwork by retained lens material, entrapped exudate, iris pigment debris, and retained viscoelastic, blood cells due to hyphema.^{6,11,15} Transient increase in IOP in the immediate post-operative period following uneventful cataract surgery is consistent with previous studies.^{3,7,17}

IOP RISE FOLLOWING CATARACT SURGERY

In our study, immediate mean post-operative rise was 2.640 mmHg which was noted in 57.73 % males and 42.26% females and was in agreement with a study by Coban et al.⁷ In our study the likely cause of IOP rise can be due to inflammation, retained viscoelastics as noted similarly by Coban et al.^{7,11} Our study revealed IOP rise in 97(97 %) patients on day 1 contradicting Lagreze et al study who observed that phacoemulsification with sutureless scleral tunnel was related with lower postoperative IOP rise 24 hours following phacoemulsification.⁷ Our study showed females revealed 2.698 mm Hg, rise in day 1 whereas Ahmed et al revealed 50 % rise in post-operative IOP with no gender prediction.^{3,7} Sharma et al post-operative IOP elevation in extra capsular cataract extraction (ECCE) had IOP spike of 19.63±2.75 mm Hg from baseline 15.82±2.77 mm Hg on day 1 followed by significant reduction on day 2 (19.33±2.66 mm Hg) and considerable decrease (16.95±2.71 mm Hg) at 1 week, similar to our study result which revealed significant IOP rise in day 1 (18.40 ± 2.1 mm Hg) from baseline IOP (15.76 ± 2.1 mm Hg) (p<0.05).⁶ activation of cytokines, endogenous prostaglandin F2 release causes increase in aqueous outflow by expansion of the trabecular meshwork and the lumen of Schlemm's canal which could have been the cause of reduction in our study.^{2, 12, 15} Pohjalainen et al showed that transient IOP peaks one day after phacoemulsification are common in non-glaucomatous patients with pseudo exfoliation (PXF), however similar result were observed in our study in eyes without PXF.^{6,7,11} As the surgical inflammation subsides and the residual viscoelastic and pigment debris is removed from the eye, the IOP tends to normalise.^{2,7,12}

IOP REDUCTION FOLLOWING CATARACT SURGERY

Calissendroff et al illustrated that leakage of aqueous through the tunnel, which is clinically unacknowledged aids in reduction of postoperative IOP in MSICS.² Our study revealed mean -2.120 mm Hg reduction at 6th week following MSICS which abides with similar studies on phacoemulsification.¹⁷ Cho et al showed IOP rise of mean 2.06 mmHg at 5th week postoperatively in phacoemulsification contradicting to our study which reveals reduction.⁷ Miyake et al stated that blood-ocular barrier permeability is increased after cataract surgery and IOL implantation resulting in IOP reduction.² Numerous studies have shown significant IOP

reduction after phacoemulsification. Yang et al reported a mean reduction in IOP of 1.6 mmHg at 3 months of follow-up in Korean eyes undergoing uncomplicated phacoemulsification. In our study, 6th week IOP reduction was nearly 1 mmHg more (2.1207 mmHg) abiding to known literature.¹⁷ Lens position appears to show greater predictive value regarding IOP reduction.^{4,5} It is a convenient and simple parameter to calculate and obtain since ocular biometry measurements are required before cataract surgery for IOL power calculation.^{4,8} Explanation for the decrease in IOP after cataract surgery with PCIOL implantation is also due to increased anterior chamber depth likely due to reduction in lens volume resulting in decreased resistance to aqueous outflow.⁵

IOP reduction following cataract surgery occur also due to effects of surgery on the ciliary body.^{4,17} Studies have shown high levels of prostaglandins (F2) in aqueous humor contributing to reduction in IOP.^{7,12} A study conducted by Pal et al showed mean IOP reduction at 4 to 6 week in ECCE and phacoemulsification in 117 Indian eyes which was found to be identical to our values in uncomplicated MSICS.^{7,17} Changes in IOP following phacoemulsification have been described whereas changes in MSICS and posterior chamber IOL implantation remains to be investigated.¹⁴ Previous studies show that there is a statistically significant post-operative IOP reduction in both ECCE and phacoemulsification groups ($p < 0.01$). However, the magnitude of reduction was not significantly different between groups. ($p > 0.05$).^{14, 18} Our study showed similar result to published literature.^{1, 7}

V. Conclusion

Uncomplicated MSICS showed marginal reduction in IOP at six weeks after surgery, Study with a large sample size and longer follow-up shall give definite answer. Inclusion of patients with glaucoma in such a study shall reveal the effects MSICS in glaucoma management,

References

- [1]. Kato Y, Nakakura S, Asaoka R, Matsuya K, Fujio Y, Kiuchi Y, et al. Cataract surgery causes biomechanical alterations to the eye detectable by Corvis ST tonometry. Wedrich A, editor. PLOS ONE. 2017 Feb 21;12(2):e0171941.
- [2]. Browning AC, Alwitry A, Hamilton R, Rotchford A, Bhan A, Amoaku WM. Role of intraocular pressure measurement on the day of phacoemulsification cataract surgery. J Cataract Refract Surg. 2002 Sep;28(9):1601–6.
- [3]. Gupta A, Vernon SA. Is the 1-day postoperative IOP check needed post uncomplicated phacoemulsification in patients with glaucoma and ocular hypertension? Eye. 2015 Oct;29(10):1299–307.
- [4]. Yang HS, Lee J, Choi S. Ocular Biometric Parameters Associated With Intraocular Pressure Reduction After Cataract Surgery in Normal Eyes. Am J Ophthalmol. 2013 Jul;156(1):89–94.e1.
- [5]. Coh P, Moghimi S, Chen RI, Hsu C-H, Masís Solano M, Porco T, et al. Lens Position Parameters as Predictors of Intraocular Pressure Reduction After Cataract Surgery in Glaucomatous Versus Nonglaucomatous Eyes. Investig Ophthalmology Vis Sci. 2016 May 10;57(6):2593.
- [6]. Sharma PD, Madhavi MR. A comparative study of postoperative intraocular pressure changes in small incision vs conventional extracapsular cataract surgery. Eye. 2010 Apr;24(4):608–12.
- [7]. Grzybowski A, Kanclerz P. Early postoperative intraocular pressure elevation following cataract surgery. Curr Opin Ophthalmol. 2019 Jan;30(1):56–62.
- [8]. Bilak S, Simsek A, Capkin M, Guler M, Bilgin B. Biometric and Intraocular Pressure Change after Cataract Surgery. Optom Vis Sci. 2015 Apr;92(4):464–70.
- [9]. Lv H, Yang J, Liu Y, Jiang X, Liu Y, Zhang M, et al. Changes of intraocular pressure after cataract surgery in myopic and emmetropic patients. Medicine (Baltimore). 2018 Sep;97(38):e12023.
- [10]. Atalay E, Nongpiur ME, Baskaran M, Perera SA, Wong TT, Quek D, et al. Intraocular pressure change after phacoemulsification in angle-closure eyes without medical therapy. J Cataract Refract Surg. 2017 Jun;43(6):767–73.
- [11]. Levkovitch-Verbin H, Hahot-Wilner Z, Burla N, Melamed S, Goldenfeld M, Bar-Sela SM, et al. Intraocular Pressure Elevation within the First 24 Hours after Cataract Surgery in Patients with Glaucoma or Exfoliation Syndrome. Ophthalmology. 2008 Jan;115(1):104–8.
- [12]. Melancia D, Abegão Pinto L, Marques-Neves C. Cataract Surgery and Intraocular Pressure. Ophthalmic Res. 2015;53(3):141–8.
- [13]. Park J-H, Yoo C, Song J-S, Lin S, Kim Y. Effect of cataract surgery on intraocular pressure in supine and lateral decubitus body postures. Indian J Ophthalmol. 2016;64(10):727.
- [14]. Pal V, Ajai A, Suman S, Pratap V. Long-term change in intraocular pressure after extracapsular cataract extraction with posterior chamber intraocular lens implantation versus phacoemulsification with posterior chamber intraocular lens implantation in Indians. Middle East Afr J Ophthalmol. 2013;20(4):332.
- [15]. Kim JY, Jo M-W, Brauner SC, Ferrufino-Ponce Z, Ali R, Cremers SL, et al. Increased intraocular pressure on the first postoperative day following resident-performed cataract surgery. Eye. 2011 Jul;25(7):929–36.
- [16]. Todorović M. Intraocular Pressure Changes after Uneventful Phacoemulsification in Early Postoperative Period in Healthy Eyes. Acta Clin Croat [Internet]. 2019 [cited 2022 Jan 17]; Available from: https://hrcak.srce.hr/index.php?show=clanak&tid_clanak_jezik=334711
- [17]. Sengupta S, Venkatesh R, Krishnamurthy P, Nath M, Mashruwala A, Ramulu PY, et al. Intraocular Pressure Reduction after Phacoemulsification versus Manual Small-Incision Cataract Surgery. Ophthalmology. 2016 Aug;123(8):1695–703.
- [18]. Onakpoya OH, Adeoye AO, Adegbehingbe BO, Badmus SA, Adewara BA, Awe OO, et al. Intraocular pressure variation after conventional extracapsular cataract extraction, manual small incision cataract surgery and phacoemulsification in an indigenous black population. Pan Afr Med J [Internet]. 2020 [cited 2022 Jan 17];36. Available from: <https://www.panafrican-med-journal.com/content/article/36/119/full>