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To Compare Changes in Intraocular Pressure in Glaucomatous and Non Glaucomatous Subjects Pre and Post Phacoemulsification

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Abstract: ***Background and objectives: Cataract and glaucoma are the first and second leading cause of blindness worldwide[1-3]. Intraocular pressure is the only known modifiable risk factor in management of glaucoma[3]. This prospective observational study was done to study changes in intraocular pressure in glaucomatous and non glaucomatous eyes undergoing phacoemulsification with intraocular lens implantation. Methods: 75 glaucomatous and 75 non glaucomatous subjects were evaluated in the eye OPD of tertiary care centre from January 2020 to September 2021. Evaluation included assessment of intraocular pressure in the eye undergoing phacoemulsification pre and post operatively on day 1, day 7, 1 month, 3 month and 6 month along with collection of basic information like age, sex. Results: The mean intraocular pressure at day 1, Day 7, 1 month, 3 month and 6 month was significantly more among glaucomatous. Interpretation & Conclusion: Phacoemulsification results in IOP reduction. In cases of higher preoperative IOP, phacoemulsification and Intraocular lens implantation is a reliable option for IOP control.***

Keywords: Cataract, Glaucoma, Intraocular pressure, Phacoemulsification

1. Introduction

Cataract and glaucoma are the first and second leading cause of blindness worldwide[1-3].The incidences of both cataract and elevated intra ocular pressure (IOP), with or without glaucoma, increases with age[4]. IOP is the only known modifiable risk factor in management of glaucoma[3]. A decrease in intraocular pressure (IOP) after cataract surgery has been reported in both glaucomatous and non-glaucomatous eyes[5].Normal intraocular pressure, in nonglaucomatous eyes, varies in the population between 10 to 21 mm Hg.[6].The widespread general belief that cataract extraction alone lowers IOP 2-4 mmHg is slowly evolving towards an understanding of a larger and more sustained IOP reduction, especially in patients with higher preoperative IOP[7-9]. Cataract surgery seems to be emerging as a safe to lower IOP in patients with mild to moderate glaucoma while avoiding morbidity of traditional glaucoma surgery[10]. IOP can be controlled in 20% of patients with open angle glaucoma (OAG) without drops following cataract surgery.[11] Although the physiological reasons for decreased IOP after cataract surgery remain speculative, the facility of out-flow is known to increase after cataract surgery.[12] The angle width does not change in normal or OAG patients after cataract surgery suggesting improved function of trabecular meshwork itself rather than improved aqueous access to the trabecular meshwork.[13]

As the eye ages the crystalline lens increases significantly in volume. This may initiate a series of anatomical changes, that ultimately leads to increase in IOP observed with aging .The lens can incur angle narrowing by pushing the peripheral iris anteriorly, which the effect will be more marked if the lens is cataractous[14-15].

As the lens grows, the anterior lens capsule is displaced forward causing the zonules to place anteriorly directed traction on the ciliary body and uveal tract, which in turn compresses the canal of Schlemm and trabecular meshwork, as the ciliary body is displaced forward by the enlarging lens the tendons relax and the space between trabecular plates becomes narrowed.[16] Phacoemulsification typically induces low grade inflammation in the immediate postoperative period.[17] This may lowers IOP by either decreasing aqueous production of ciliary body as seen in uveitis; or it could increase outflow similar to the mechanism of selective laser trabeculoplasty or prostaglandin analogues. An additional explanation is that high flow of fluid and high IOP (up to 90 mmHg) experienced during cataract surgery forces fluid through the trabecular meshwork into the canal of Schlemm and episcleral veins.[18,19] Forcing this large amount of fluid through the drainage system may increase patency and promote flow. Again, there is little evidence to support or refute this hypothesis.

Cataract surgery is a very common and highly refined surgery with a favourable risk/benefit profile including improved visual acuity and visual field.[20] The widespread general belief that cataract extraction alone lowers IOP 2-4 mmHg is slowly evolving towards an understanding of a larger and more sustained IOP reduction, especially in patients with higher preoperative IOP.[21-23] Even though cataract surgery alone lowers IOP, combined cataract/glaucoma surgery lowers IOP more with fewer postoperative pressure spikes.[22-24] Cataract surgery to lower

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IOP may be especially beneficial in developing countries or where the close follow-up necessitated by traditional glaucoma surgery is difficult. Nonetheless, cataract surgery seems to be emerging as a safe to lower IOP in patients with mild to moderate glaucoma while avoiding morbidity of traditional glaucoma surgery.[25]

The objective of this study was to evaluate the effect of phacoemulsification on intraocular pressure in glaucomatous eye and non glaucomatous eye.

2. Material and Methods

This prospective observational study was conducted according to the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee, Government Medical College, Haldwani, Nainital (Uttarakhand) in the outpatient department of ophthalmology at tertiary care centre from January 2020 to September 2021 in which 150 subjects were included .75 patient were glaucomatous and 75 were non-glaucomatous. Intraocular pressure was measured by Goldmann applanation tonometer.

Inclusion criteria-

1) Patient who had phacoemulsification with posterior chamber intraocular lens implantation.
2) Glaucoma patients with medically controlled open angle glaucoma (pre operative IOP <22 mm Hg under medication) attending glaucoma clinic .
3) Glaucoma has been diagnosed in cases where glaucomatous visual field defect matched optic disc changes.
4) Healthy subjects from general ophthalmology clinic. Criteria is normal anterior segment on slit lamp examination, IOP between 10 and 21 mm Hg, cup to disc ratio of <0.6, no retinal nerve fiber layer(RNFL), defects in red free RNFL photographs and no glaucomatous VF defects.
5) Primary angle closure suspect
6) Primary angle closure glaucoma

Exclusion Criteria

1) Primary angle closure attack
2) Ophthalmic disease (other than cataract) that could affect IOP
3) Secondary glaucoma such as lens induced glaucoma, neovascular glaucoma
4) Patient has undergone any non glaucoma related surgical or laser procedure such as laser capsulotomy following phacoemulsification
5) Patient having traumatic cataract.

3. Results

Table 1: Distribution of Mean age among study population

	Age				
	Mean	Std. Deviation	Mean Change	t-test value	p-value
Glaucomatous	63.99	12.74	1.05	0.519	0.604
Non-Glaucomatous	62.93	12.10			
Over-all	63.46	12.39			

The mean age of study population among Glaucomatous group was 63.99±12.74 years, Non-Glaucomatous was 62.93±12.10 years and Over-all study population was 63.46±12.39 years.

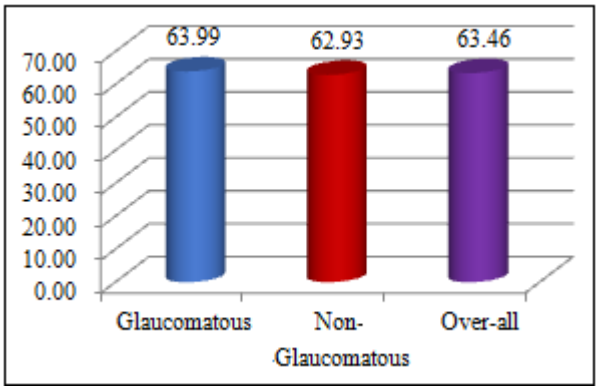

Figure 2: Distribution of Mean age among study population

Table 2: Distribution of Gender among study population

Gender	Groups		Total
	Glaucomatous	Non-Glaucomatous	
Male	42	38	80
	56.0%	50.7%	53.3%
Female	33	37	70
	44.0%	49.3%	46.7%
Total	75	75	150
	100.0%	100.0%	100.0%

There were 80 (53.3%) males and 70 (46.7%) females among study population.

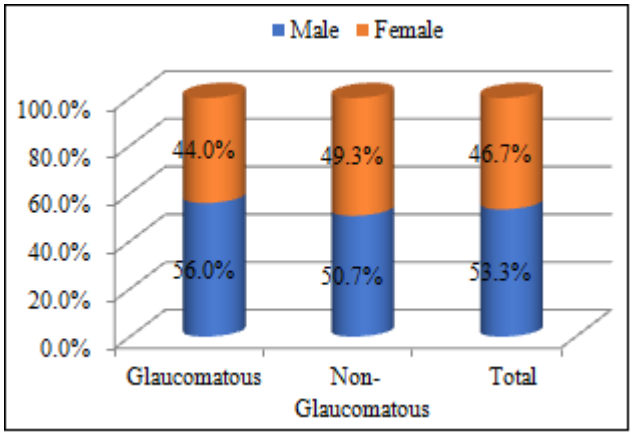

Figure 2: Distribution of Gender among study population

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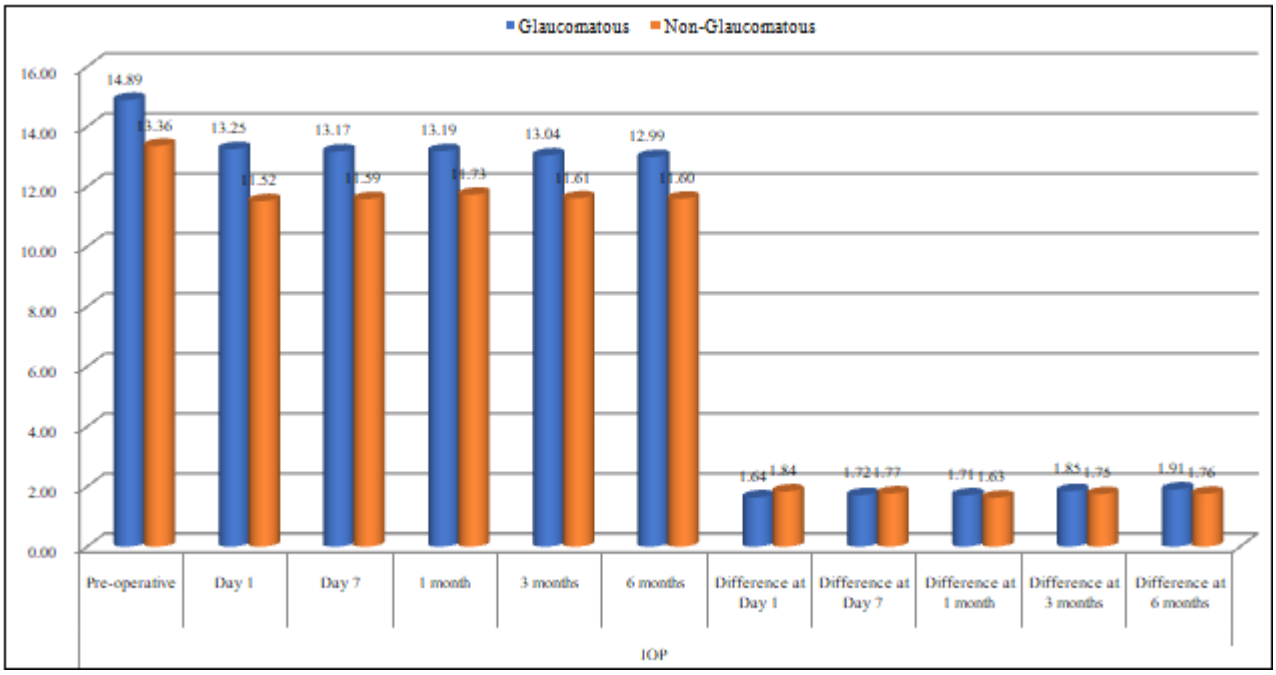
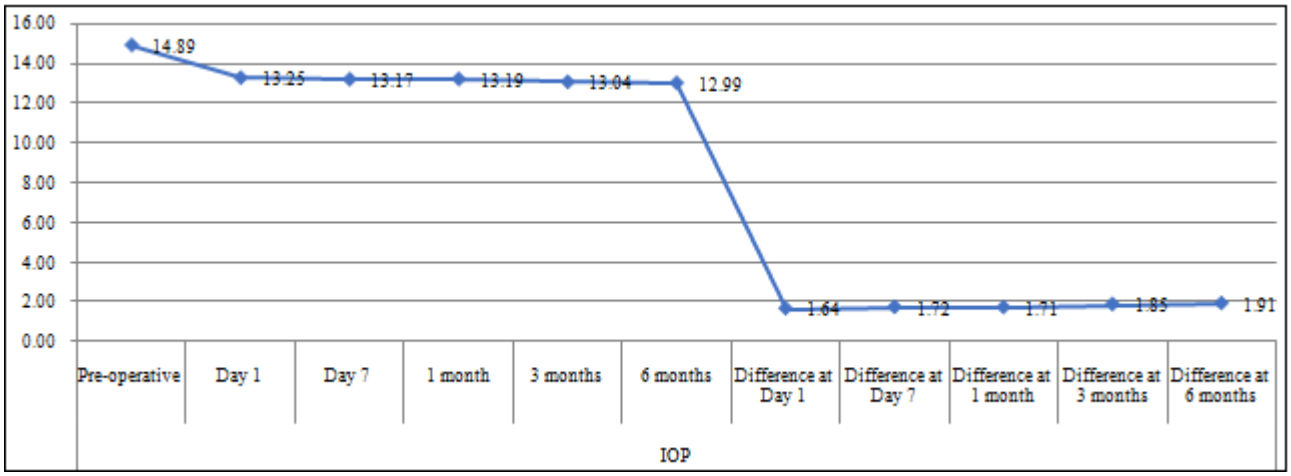
Table 3: Comparison of mean IOP at pre-operatively and post-operatively Day 1, Day 7, 1 month, 3 months and 6 months, Difference at Day 1, Difference at Day 7, Difference at 1 month, Difference at 3 months and Difference at 6 months between Glaucomatous and Non-Glaucomatous

IOP	Glaucomatous		Non-Glaucomatous		Mean Difference	t-test value	p-value
	Mean	Std. Deviation	Mean	Std. Deviation			
Pre-operative	14.89	3.64	13.36	2.40	1.53	3.046	0.003*
Day 1	13.25	3.34	11.52	2.32	1.73	3.693	0.001*
Day 7	13.17	2.94	11.59	1.91	1.59	3.916	0.001*
1 month	13.19	2.73	11.73	1.85	1.45	3.818	0.001*
3 months	13.04	2.69	11.61	1.78	1.43	3.829	0.001*
6 months	12.99	2.66	11.60	1.82	1.39	3.720	0.001*
Difference at Day 1	1.64	2.40	1.84	2.46	-0.20	-0.504	0.615
Difference at Day 7	1.72	2.10	1.77	1.65	-0.05	-0.173	0.863
Difference at 1 month	1.71	1.89	1.63	1.37	0.08	0.297	0.767
Difference at 3 months	1.85	1.81	1.75	1.39	0.11	0.405	0.686
Difference at 6 months	1.91	1.73	1.76	1.22	0.15	0.601	0.548

The mean IOP at pre-operatively, day 1, Day 7, 1 month, 3 months and 6 months, Difference at Day 1, Difference at Day 7, Difference at 1 month, Difference at 3 months and Difference at 6 months was compared between Glaucomatous and Non-Glaucomatous using the unpaired t-test. The mean IOP at day 1, Day 7, 1 month, 3 months and 6 months was significantly more among Glaucomatous group. There was no significant difference in mean reduction in IOP at day 1, at day 7, at 1 month, at 3 months and at 6 months between Glaucomatous and Non-Glaucomatous groups.





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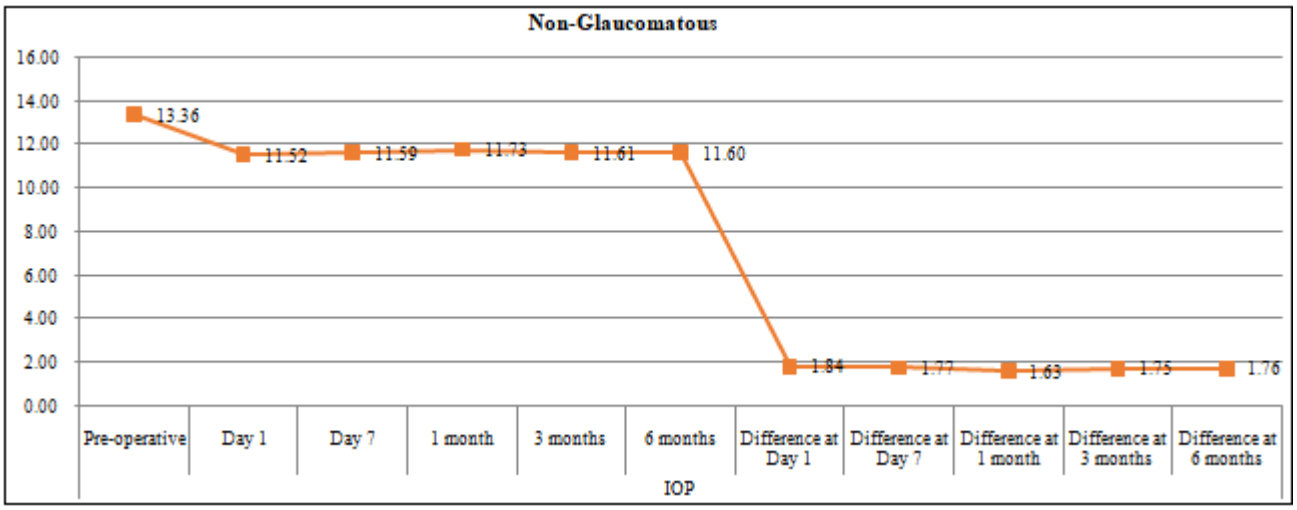

Figure 3: Comparison ofmean IOP at pre-operatively and post-operatively Day 1, Day 7, 1 month, 3 months and 6 months, Difference at Day 1, Difference at Day 7, Difference at 1 month, Difference at 3 months and Difference at 6 months between Glaucomatous and Non-Glaucomatous

4. Discussion

This study was performed to evaluate if there is a change in intraocular pressure (IOP) after cataract surgery with phacoemulsification.The mean age of study population among Glaucomatous group was 63.99±12.74 years, Non-Glaucomatous was 62.93±12.10 years and Over-all study population was 63.46±12.39 years.This was in similarity to the study by *Ali et al*,[26] the mean age of patients was 62.87±7.90 years.

There were 53.3% males and 46.7% females among study population in the present study. This was in similarity to the study by *Ali et al*,[26] there were 57.89% males and 42.11% females and *Prathapan et al*,[27] there was predominance (51.1%)of males.

The mean IOP at day 1, Day 7, 1 month, 3 months and 6 months was significantly more among Glaucomatous group. There was no significant difference in mean reduction in IOP at day 1, at day 7, at 1 month, at 3 months and at 6 months between Glaucomatous and Non-Glaucomatous groups.*Ramli et al*[28]showed significant reduction of IOP at one week and one month afterphacoemulsification, with mean IOP reduction of 1.77 mmHg at one month postoperatively.The present findings were similar to previous studies conducted innon-glaucomatous patients, which showed a reduction in IOP between 1.26 mmHgand 2.82 mmHg.[29-31].Our study was similar to the findings by *Sambhav K and Sasidharan A*,[32] the mean preoperative IOP was 14.17±3.47 mmHg and *Al Anazi NM et al.*,[33] the mean preoperative IOP was 14.12 mmHg. The mean postoperative IOP in the study by *Sambhav K and Sasidharan A*[32] was 13.24±3.66 mmHg and in *Al Anazi NM et al.*,[33] was 13.5 mmHg. The mean reduction in IOP after phacoemulsification in the study by Sambhav K and Sasidharan A[32] and Al Anazi NM et al.,[33] where it was 0.93 and 0.6 mmHg, respectively.

Zamani et al[34]observed a significant reduction in IOP in eyes with open angles and both normal or high IOP, 1 and 6 weeks after phacoemulsification and IOL implantation. IOP reduction was proportional to preoperative IOP, i.e. the higher the preoperative IOP, the greater the reduction in postoperative IOP.Different Studies have reported that cataract extraction alone lowers IOP two to four mm Hg which correlates with our results.

A possible explanation for IOP reduction after cataract surgery in eyes with primary angle closure and narrow angles is widening of the angle and altered configuration of the ciliary body. *Nonaka et al*[35] found that ACD, angle opening distance at 500 microns anterior to the scleral spur and the trabecular- ciliary process distance increased significantly after cataract surgery. The authors concluded that cataract surgery attenuates anterior positioning of the ciliary processes and widens the anterior chamber angle in eyes with PACG.

A number of studies reported similar reductions in IOP after cataract surgery in patients with primary open angle glaucoma (POAG) and also in normal subjects[36,11,13,19]. *Wang et al*[37]suggested that phacoemulsification thins the iris and leads to smaller pupil diameters up to a year after the initial surgery. Potential mechanisms of iris thinning during routine phacoemulsification include direct trauma from the phaco probe and indirect damage to iris structures from the cavitation energy generated by the phaco tip.[38] While the exact effects of mechanical phacoemulsification energy on iris stroma are unknown, existing literature suggests that on a histopathological level, phaco-generated ultrasonic waves induce intracytoplasmic vacuolation within the sphincter and dilator muscles of both human and simian irises.[39,40]

Phacoemulsification and IOL implantation reconfigures the anterior segment to its position earlier in life. By returning the anterior lens capsule to a more posterior location, the zonules exert posterior traction on the ciliary body and scleral spur. This results in expansion of the trabecular meshwork and Schlemm's canal. This expansion improves function of the trabecular meshwork and valves in Schlemm's canal. Ultimately, outflow facility increases and IOP decreases. The implanted artificial lens does not enlarge with time, hence IOP does not change postoperatively.[37]

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5. Conclusion

The mean age of study population among Glaucomatous group was 63.99±12.74 years, Non-Glaucomatous was 62.93±12.10 years and over-all study population was 63.46±12.39 years with 53.3% males and 46.7% females.

The mean IOP at day 1, Day 7, 1 month, 3 months and 6 months was significantly more among Glaucomatous group (14.89±3.64, 13.25±3.34, 13.17±2.94, 13.19±2.73, 13.04±2.69 and 12.99±2.66 respectively). There was no significant difference in mean reduction in IOP at day 1, at day 7, at 1 month, at 3 months and at 6 months between Glaucomatous (1.64±2.40, 1.72±2.10, 1.71±1.89, 1.85±1.81 and 1.91±1.73 respectively) and Non-Glaucomatous (1.84±2.46, 1.77±1.65, 1.63±1.37, 1.75±1.39 and 1.76±1.22 respectively) groups.

Phacoemulsification results in IOP reduction, which effect was lessened in healthy subjects and glaucoma patients over the course of a long-term follow up. In cases of higher preoperative IOP and young patients, phacoemulsification alone is a reliable option for IOP control. However, we also should consider the risk of early-phase IOP elevation and IOP failure. Above all, notwithstanding the fact that IOP reduction can be achieved after phacoemulsification in the early phase of follow up, long-term monitoring of IOP change is necessary, because the effect of IOP reduction cannot necessarily be maintained. We hope that our results will prove useful to physicians who are planning cataract management, especially for patients with glaucoma.

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