

PREOPERATIVE OCULAR HYPOTONY BY EXTERNAL COMPRESSION BALANCED WEIGHT

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AIMS: A prospective study was carried out. 1. To find out the correlation between the baseline pulse pressure and baseline intraocular pressure. 2. To find out correlation between duration of ocular compression and intraocular pressure lowering effect with ocular compression by balanced weight. 3. To find out any correlation between baseline pulse pressure and intraocular pressure lowering effect with ocular compression by balanced weight.

METHODS MATERIALS: 100 randomly selected cases having uncomplicated cataract were divided in to 4 study groups of 25 cases each. The baseline intraocular pressure (IOP) and pulse pressure were noted. After giving peribulbar block with the same volume of injection they were subjected to a standard amount of ocular compression of 380 grams for a variable time duration of 5, 7, 10 and 12.5 minutes respectively. The intraocular pressure was noted again before and after the ocular compression. Statistical analysis was done by unpaired t test.

RESULTS: Cases with pulse pressure range of 31-40 mm Hg, 41-50 mmHg and ≥ 51 mm Hg had mean baseline intraocular pressure 13.83(SD1.71) mm Hg, 14.83(SD2.00) mm Hg and 17.42(SD1.80) mm Hg respectively ($P < 0.001$). The cases in study group A (5 minutes of ocular compression), B (7.5 minutes), C (10 minutes) and D (12.5 minutes) had mean IOP lowering equal to 6.18 (SD 0.66) mm Hg, 6.80 (SD 0.81) mm Hg, 7.70 (SD 0.56) mm Hg and 8.50 (SD 0.67) mm Hg respectively ($P < 0.001$). unpaired t test was used for stastical analysis.

CONCLUSIONS: 1. There is a tendency of increased level of baseline IOP in the cases with increased level of pulse pressure. 2. Increased duration of ocular compression increases the IOP lowering effect. 3. There exists no definite correlation between the baseline pulse pressure and the intraocular pressure lowering tendency for variable durations of ocular compression.

KEYWORDS: Balanced Weght, Ocular Compression, Pulse Pressure.

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INTRODUCTION: A preoperative and intraoperative moderately soft eye is essential for safe and uncomplicated cataract extraction, especially when intraocular lens implantation has to be done and this can be achieved by preoperative reduction of intraocular pressure (IOP). In a soft eye, anterior chamber deepens and iris falls back during surgery and thus making implantation of intraocular lens easier and safer. There is also minimal risk of vitreous loss during surgery.

The external pressure to the eyeball is made up of the actions of the extraocular muscles and the lids as well as the pressures inherent in the manoeuvres of the operation. Complete anaesthesia and akinesia of the lids and orbital muscles reduces the external scleral pressure to a considerable degree.

During cataract extraction, as soon as the sclera is incised, the intraocular pressure equates with the atmospheric pressure. If the pressure is too high, at the time of incision, the intraocular contents like iris, lens,

vitreous and retina, may be expelled through the incision.^[1] Also sudden decompression of a hypertensive eye may cause an expulsive haemorrhage in the eye due to rupture of sclerotic short posterior ciliary artery.^[2]

Peri or retrobulbar injection markedly increases intraocular pressure. Ocular compression is necessary in vision-saving as it allows even a small amount of fluid to move across fenestrations in the orbital septum out into the veins and lymphatics of the anterior orbit.^[3] Apart from reducing the surgical complications, the preoperative ocular compression also helps in uniform distribution of the local anaesthetics across the globe and thus helps in producing better akinesia and anaesthesia of the eye.

Mechanism of IOP decrease after ocular compression:

1. Decreasing the volume of the vitreous, which is about 50% water in elderly patients.
2. Decreasing the volume of the orbital contents, other than the globe, by increasing the systemic absorption of orbital extracellular fluid, including, presumably, injected fluids such as anaesthetics.
3. Increasing the aqueous outflow facility mechanism.^[4]

Various methods for reduction of IOP prior to surgery:

- A. Medical methods: Intravenous mannitol, Diamox orally, Glycerol orally

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B. Mechanical pressure:

This can be achieved by application of: Digital pressure, pressure bandage, Super pinky, Paediatric B.P. cuff, Honan Intraocular pressure reducer (HIPR) and Balanced weight.

Digital pressure method can be effective and safe if carefully applied but how much pressure is given can not be predicted.^[5]

Balanced weight is made of ordinary steel or stainless steel. This was introduced by Prof. F. Muller, West Germany. The weight is placed over a folded eye pad placed over the closed eye lids. Effective hypotony with the intraocular pressure less than 10 mmHg is obtained in 3 to 4 minutes. If further hypotony is needed the weight should be removed for about 30 seconds and can be placed again for a further 3 minutes. The hypotony is achieved by dehydration of vitreous and also by orbital decompression.^[5] It is important to close the eyelids before covering the eye with gauze and applying the device as there is risk of corneal erosion.

Throughout the ocular compression, there should be attention to the patient's diastolic blood pressure, divided approximately in half, which is a rough approximation of what the central retinal artery diastolic pressure and the extra ocular pressure should never exceed that figure. A recommended dial pressure of 30 mm Hg might be excessive in the patient with a systemic diastolic pressure of 50 mm Hg with a low pulse pressure. Retinal vascular occlusion can occur if higher pressure is exerted by the above methods.

ADVANTAGES:

1. It is convenient and easy to apply.
2. It is a less laborious method as compared to finger pressure method.
3. The amount of pressure (380 grams) applied is roughly equivalent to 30 mm Hg.

When systolic blood pressure rises, there is increased capillary pressure in the ciliary body which results increased aqueous humour formation by the process of ultrafiltration resulting in increased IOP. Blood pressure may also affect episcleral venous pressure, which is important in regulating the flow of aqueous across the trabecular meshwork into Schlemm's canal.^[6,7]

MATERIALS AND METHODS: 100 cases including both men and women, over the age of 40 years having uncomplicated cataract were selected at random. The cases were divided in to 4 study groups of 25 cases each. A thorough examination with oblique illumination and with slit lamp was conducted to ascertain the nature of cataract and rule out any associated ocular abnormality. The intraocular pressure was noted with Schiotz tonometer to rule out any coexistence of ocular hypertension.

Exclusion Criteria: The cases with the following conditions were not included in the study such as:-

- a) Aphakia.
- b) Pseudophakia.

- c) Patients who have undergone keratoplasty or fistulating procedure for glaucoma.
- d) vascular occlusions and blood dyscrasia.
- e) patients under medical treatment for asthma, diabetes, hypertension.
- f) ischemic or inflammatory optic nerve disease.
- g) ocular trauma.
- h) systemic hypertension with systolic blood pressure > 150 mm of Hg.
- i) Pulse pressure < 30 mm of Hg.

After selection and before inclusion in the study group, a written consent of the individual case was taken after explaining the nature of study and its prognosis and consequences. The study was conducted with approval from ethical committee.

Intraocular pressure with schiotz tonometer as well as systolic blood pressure, diastolic blood pressure and pulse pressure were noted before peribulbar anaesthesia. Peribulbar anaesthesia was given with injection of 2% solution of xylocaine and 0.5% sensoricaine in equal quantities and the volume injected remained same in all the cases. Intraocular pressure was again noted just before applying ocular compression with the balanced weight (380 gm) on the eyeball [Figure 1]. The duration of ocular compression was as follows:

Group A: cases were subjected to ocular compression of 5minutes.

Group B: for 7.5 minutes.

Group C: for 10 minutes.

Group D: for 12.5 minutes.

The pressure was released after every 5minutes for 30 seconds to prevent ocular ischemia. The intraocular pressure was noted again after ocular compression in each group. The findings were noted and the data was compiled and analysed statistically using unpaired t test.

RESULTS: The cases were subjected to the same amount of ocular compression (380 grams) but for a variable time duration.

Out of 100 cases, 54% were males and 46% were females. The age of the cases under this study varied from 41 to 80 years.

Table 1: Showing mean baseline IOP (before dilatation) in relation to baseline pulse pressure.

In the study, 15 cases with pulse pressure within the range of 31-40 mm Hg were having mean baseline IOP equal to 13.83 ± 1.71 mm Hg, 38 cases with pulse pressure within the range of 41-50 mm Hg were having mean baseline IOP 14.83 ± 2.00 mm Hg and 47 cases with pulse pressure ≥ 51 mm Hg were having mean baseline IOP 17.42 ± 1.80 mm Hg [Table1, Chart 1]. Thus the difference between the mean value of baseline IOP in all pulse pressure ranges is statistically highly significant as p value <0.001. Hence it indicates that with increase in baseline pulse pressure there is an increased tendency of increased level of baseline IOP.

Pulse pressure (mm of Hg).

Table 2 showing comparison of mean pre and post-compression IOP levels in different study groups.

The mean pre-compression (after anaesthesia) IOP values in study groups A, B, C and D were $17.02(SD3.07)$,

17.72(SD2.06), 18.17(SD1.84) and 18.21(SD1.86) mm Hg respectively. The mean post-compression IOP values in study groups A, B, C and D were 10.85(SD2.89), 10.92(SD1.85), 10.47(1.72) and 9.71(SD1.64) mm Hg respectively [Table 2, Chart 2]. Thus a marked reduction in the mean IOP was observed after ocular compression with the balanced weight of 380 grams.

Table 3 showing mean IOP lowering effect in various study groups. The cases in study group A had mean IOP lowering equal to 6.18 (SD 0.66) mm Hg, cases in study group B had 6.80 (SD 0.81)mm Hg, cases in study group C had 7.70 (SD 0.56) mm Hg and cases in study group D had 8.50 (SD 0.67) mm Hg [Table 3, Chart 3]. The difference between mean intraocular pressure lowering values in all study groups was statistically highly significant ($p < 0.001$). Thus there was an increased IOP lowering effect with the increased duration of ocular compression with the same standard balanced weight of 380 grams.

It indicates that with the same standard amount of ocular compression, an enhanced level of IOP lowering effect can be achieved by enhancing the time duration of ocular compression.

Table 4 showing the mean IOP lowering effect in relation to pulse pressure and time duration of compression. From the data in the table it is evident that there is no significant difference in the mean value of IOP lowering effect in the cases with increasing range of pulse pressure in study group A, B, C and D cases.

The relation between IOP lowering effect and baseline pulse pressure in study group A, B, C and D is indicated by P value 0.316, 0.628, 0.093 and 0.226 respectively [Table 4, Chart 4]. So the difference between mean IOP lowering values in all the pulse pressure ranges in study groups A, B, C and D is not statistically significant as $p > 0.05$. Hence there does not exist any relationship between the IOP lowering effect due to ocular compression and the baseline pulse pressure.

DISCUSSION: The use of ocular compression immediately before cataract surgery to lower the intraocular pressure and presumably to decrease the volume of vitreous has long been advocated to minimise vitreous loss during surgery. The balanced weight is one of the devices used for preoperative ocular compression.

The amount of pressure given during digital ocular compression or super pinky is variable and cannot be graded as standardised. The present study was conducted to find out correlation between duration of ocular compression and IOP lowering effect with a standard amount of ocular compression. Also the relation of baseline pulse pressure to IOP lowering due to ocular compression has been shown.

In the previous studies it has been reported that with increase in systolic blood pressure there is tendency for higher level of baseline IOP. However, very few studies showed the relationship between pulse pressure and baseline IOP. The present study indicated that the relationship between the baseline IOP and the baseline pulse pressure is statistically highly significant as $p < 0.001$. So with increase in pulse pressure there occurred an increased tendency of baseline IOP.

Bill demonstrated that variations in systolic blood pressure (SBP) resulted in changes in aqueous humour formation, possibly related to increased capillary pressure in the ciliary body. This could result in increased IOP. Blood pressure may affect episcleral venous pressure, which is important in regulating the flow of aqueous across the trabecular meshwork into Schlemm's canal.^[6,7]

Leske et al found an association between systemic and ocular hypertension and between high DBP and open angle glaucoma.^[8]

Shiose et al indicated a positive correlation of IOP with body weight, and a positive correlation with blood pressure.^[9,10]

In a recent study by Daoping Lu et al on 155 eyes, a significant positive correlation between systolic blood pressure and IOP was found only in progressing cases of glaucoma.^[11]

In the Beaver dam study it was demonstrated that there is significant direct correlations between changes in systemic blood pressures and changes in intraocular pressure. There was a 0.21 (95% CI: 0.16 to 0.27) mm Hg increase in IOP for a 10 mm Hg increase in systolic and 0.43 (0.35 to 0.52) mm Hg increase in IOP for a 10 mm Hg increase in diastolic blood pressure.^[12]

In the present study, the cases in study group A had mean IOP lowering equal to 6.18 (SD 0.66) mm Hg, cases in study group B had 6.80 (SD 0.81)mm Hg, cases in study group C had 7.70 (SD 0.56) mm Hg and cases in study group D had 8.50 (SD 0.67) mm Hg. The difference between mean intraocular pressure lowering values in all study groups was statistically highly significant ($p < 0.001$). Thus there was an increased IOP lowering effect with the increased duration of ocular compression with the standard balanced weight of 380 grams. However, the IOP lowering was non linear with increased time duration.

Constable and Porter studied the time course of IOP decrease with ocular compression in normal eyes (without injection of anaesthetic agents), measuring IOP at 10 minute intervals for 50 minutes. They found a non-linear relation with time with the greatest drop occurring in the first 10 minutes.^[13] In our study we found the highest drop in IOP at 12.5 minutes of ocular compression.

E O'Donoghue, M Batterbury, T Lavy showed that in eyes not receiving external ocular compression IOP was still 3-6 mm Hg higher than baseline, compared with 5.2 mm Hg lower than baseline where compression was used for 4 minutes.^[14]

Quist et al used Honan's device after retrobulbar injection, at a pressure of 30 mm Hg for 5 minutes and noted an average fall of 6.5 mm Hg in intraocular pressure.^[15]

In eight glaucoma subjects, Quist found a mean decrease in intraocular pressure of 2 mm Hg immediately following a retrobulbar injection of 2 ml of anaesthetic, and a further decrease of 8 mm Hg after 5 minutes of compression. In the present study the mean IOP lowering after 5 minutes of ocular compression was found to be 6.18 (SD 0.66).

Kirsch & Steinman, in a study on 100 cases, observed an average fall of 9.6 mm Hg in intraocular pressure following digital massage.^[16] Kirsch in a further study, found a fall of 8.0mm Hg after 2.5 minutes of massage.^[17]

The increased IOP lowering in comparison to our study may be due to higher pressure during digital massage. The value for the intraocular pressure lowering was 7.2 mm Hg in studies conducted by Metz with digital massage.^[18]

Ropo et al found that the intraocular pressure was 10% higher than the pre-injection pressure at 10 minutes in eyes that did not receive ocular compression.^[19]

The amount of pressure given in digital massage can vary, that's why a standard ocular compression of 380 gram was used in our study.

Bernard Y P Chang, Wendy C Lum Hee, Roland Ling, David C Broadway, Bijan Beigi noted there was a significant reduction in IOP (mean drop of 4.82 mmHg) following peribulbar local anesthesia with balloon compression for 10 minutes.^[20] In the present study the mean IOP lowering was 7.70 (SD 0.56) after 10 minutes of ocular compression.

Richard Bowman, Christopher Liu, Nicholas Sarkies found the mean change in intraocular pressure after ocular compression of 26.31 minutes(mean) was an overall fall of 2.42 (0.49-4.34) mm Hg from the pre-injection value.^[21]

Martin et al, following application of Honan's reducer for 40 minutes after retrobulbar anaesthesia, noted an average fall of 6.7 mm Hg in intraocular pressure.^[22]

However, with such longer duration of ocular compression there is fear of ocular ischemia. So in our study releasing the pressure every 5 minutes for 30 seconds was done. A recent study by Chang and colleagues has demonstrated that peribulbar anaesthesia with or without balloon compression produced significant falls in pulsatile ocular blood flow.^[20]

Roland Ling, Bijan Beigi, Anthony Quinn and John Jacob showed there was a significant reduction in IOP after Honan balloon ocular compression (mean 6.2 mm Hg).^[23]

The results of present study contradict those of Morgan and Chandna who found that the rate of fall in IOP was comparable either with or without compression with the Honan balloon. They used a lower volume of injection (8 ml) and although the technique used was uniform between the two authors, each used a different combination of anaesthetic agent. The group receiving no oculopression had IOP values measured at 1 minute intervals using tonopen. They found that by 4 minutes post injection (without oculopression), IOP values no longer differed significantly from their pre injection levels. After that time, there was little change in IOP in any given patient which would suggest that repeated measurement with the tonopen did not lower IOP. It was still possible, however, that the tonopen was effective in lowering IOP during the first 4 minutes, when the IOP values were higher.^[24]

The relation of IOP lowering effect to the baseline pulse pressure turned out to be inconsistent in the current study. The difference between mean IOP lowering values in relation to different pulse pressure ranges in each group turned out to be statistically not significant as $p > 0.05$. It indicates that IOP lowering effect with the standard compression has no definite relation with the baseline pulse pressure. The relationship between pulse pressure and IOP lowering effect has not been reported in the studies available in the literature.

CONCLUSIONS:

1. There is a tendency of increased level of baseline IOP in the cases with increased level of pulse pressure.
2. Increased duration of ocular compression increases the IOP lowering effect.
3. There exists no definite correlation between the baseline pulse pressure and the intraocular pressure lowering tendency for variable durations of compression.

Multiple studies with larger samples should however be conducted to reach at a definite conclusion for its applicability in the clinical practice.

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Pulse pressure range (mm Hg)	No. of cases	Mean baseline IOP(mm Hg)
31-40	15	13.83±1.71
41-50	38	14.83±2.00
≥51	47	17.42±1.80
P value		<0.001

Table 1: mean baseline IOP (before dilatation) in relation to baseline pulse pressure

Study groups	No. of cases	Pre-comp IOP(mm Hg)	Post-comp IOP(mm Hg)
		Mean ± SD	Mean ± SD
A(5 mins)	25	17.02±3.07	10.85±2.89
B(7.5 mins)	25	17.72±2.06	10.92±1.85
C(10 mins)	25	18.17±1.84	10.47±1.72
D(12.5mins)	25	18.21±1.86	9.71±1.64

Table 2: comparison of mean pre and post-compression IOP levels in different study groups

Study groups	No. of cases	Mean IOP Lowering(mm Hg)
A(5 mins)	25	6.18±0.66
B(7.5 mins)	25	6.80±0.81
C(10 mins)	25	7.70±0.56
D(12.5 mins)	25	8.50±0.67
P value		< 0.001 (highly significant)

Table 3: mean IOP lowering effect in various study groups

Pulse pressure range (mm Hg)	No. of cases	Mean IOP lowering (mmHg)			
		A(5mins)	B(7.5mins)	C(10mins)	D(12.5mins)
31-40	15	5.63±0.61	6.37±0.76	7.63±0.38	8.34±0.64
41-50	38	6.19±0.60	6.85±0.59	7.41±0.70	8.30±0.82
≥51	47	6.29±0.69	6.87±0.81	7.94±0.40	8.79±0.45
P value		0.316	0.628	0.093	0.226

Table 4: mean IOP lowering effect in relation to pulse pressure and time duration of compression

