

Efficacy of dexmedetomidine premedication on attenuation of intraocular pressure changes after succinylcholine and endotracheal intubation

Sreenivas Reddy M.¹, Pradeep Hosagoudar^{2*}, Giridhar J. B.³, Y. V. Murali⁴, K. V. Srinivasan⁵

¹Assistant Professor, ²Associate Professor, ³Senior Resident, ^{4,5}Professor, Dept. of Anaesthesiology, P.E.S. Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India

***Corresponding Author:**
Email: drpaddy82@gmail.com

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Abstract

Introduction: Succinylcholine, is one of the most commonly used muscle relaxant for rapid sequence airway management. It increases the Intraocular pressure (IOP) which is deleterious in open globe injuries. We studied the effects of Inj. dexmedetomidine, a highly selective α_2 -adrenoceptor agonist, on IOP and hemodynamic responses to succinylcholine and tracheal intubation.

Materials and Methods: Sixty ASA I-II patients, scheduled for elective non-ophthalmic surgeries requiring general anesthesia were randomly premedicated by intravenous Inj. dexmedetomidine 0.4 $\mu\text{g}/\text{kg}$ (Group-D) or saline (Group-S) (30 patients each group). Heart rate (HR), mean arterial pressure (MAP), and IOP (using Schiotz tonometer) were measured 10 minutes before and after the premedication, 30 seconds after succinylcholine and at 1, 5 and 10 minutes after intubation.

Results: Ten minutes after Inj. dexmedetomidine administration, there was marked decrease in IOP. After intubation there was a rise in IOP, however it remained below baseline IOP ($p=0.315$) and remained low at 10th minute after intubation ($p<0.001$) which was statistically significant. In the control group, there was a significant rise in IOP following Inj. succinylcholine and intubation which remained above baseline IOP even at 10th minute after intubation. HR, Systolic and diastolic blood pressure, and MAP markedly increased at 1 minute following intubation in the control group whereas in dexmedetomidine group, they remained below baseline ($p<0.001$).

Conclusions: Intravenous dexmedetomidine at a dose of 0.4 $\mu\text{g}/\text{kg}$ can be used for attenuation of rise in IOP associated with succinylcholine and tracheal intubation in patients with open globe injuries.

Keywords: Dexmedetomidine, Eye, Intraocular pressure, Rapid sequence intubation, Succinylcholine.

Introduction

Emergency ophthalmic surgery pose a great challenge to the anesthesiologist. When the eye globe is open, any factor that increases the intraocular pressure (IOP) may possibly cause drainage of the aqueous humor or extrusion of the vitreous humor through the wound, which can permanently damage vision. These patients require rapid sequence induction and intubation without increasing the intraocular pressure.¹

The intraocular pressure refers to the pressure exerted by intraocular fluids on the coats of the eyeball. The normal IOP ranges between 11-21 mmHg and IOP varies with the time of day, heart rate, blood pressure level and respiration.² The major factors controlling IOP are the dynamic balance between aqueous humor production in the ciliary body and its elimination via the canal of Schlemm.

Succinylcholine, the most commonly used depolarizing muscle relaxant for rapid sequence airway management, increases the IOP by contraction of extraocular muscles. Succinylcholine stimulates the tonic system, thereby increasing the IOP.³ Laryngoscopy and tracheal intubation further aggravate the rise in IOP.

Dexmedetomidine is a highly selective α_2 -adrenergic agonist that has IOP-lowering properties. It is a more selective α_2 -agonist with a 1600 times greater selectivity for the α_2 receptor compared with α_1 receptor.

It causes dose dependent reductions in blood pressure and heart rate. Other beneficial effects of dexmedetomidine are anxiolysis, sedation, analgesia and sympatholysis with minimal respiratory depression.⁴ It has been observed that the rise of IOP with succinylcholine and intubation can be blunted with dexmedetomidine premedication.⁵

Materials and Methods

A prospective, randomized, controlled study was undertaken after obtaining Institutional Ethics Committee approval as well as informed consent from all patients. Sixty patients with ASA physical status grade I, II of either sex between 20 to 60 years of age scheduled for various elective non-ophthalmic surgeries necessitating general anesthesia were included in the study. Patients were randomly allocated by envelope method into 2 groups of 30 patients each- Group S (n=30) received normal saline whereas patients in Group D (n=30) received Inj. dexmedetomidine (i.v.) 0.4 $\mu\text{g}/\text{kg}$ body weight. Patients with age < 20 years and >60 years, hypertension, obesity with body mass index >30, ischemic heart disease (IHD), diabetes mellitus, raised IOP or any other ophthalmic disease, ASA physical status grade III & IV, difficult airway, contraindication to dexmedetomidine or if the tracheal intubation could

not be performed at the first attempt were all excluded from the study.

IOP was measured with Schiotz tonometer by an ophthalmologist who was unaware of the premedication drugs used. Topical 4% lignocaine was instilled on the cornea 2 minutes prior to IOP measurement. Intraoperative monitoring included three-lead ECG, non-invasive blood pressure, plethysmography, capnography, temperature and neuromuscular monitoring.

Patients in Group-S received 50 ml of normal saline i.v., whereas in Group-D Inj.dexmedetomidine 0.4 µg/kg diluted to 50 ml using normal saline i.v. administered over 10 minutes using syringe infusion pump before induction of anesthesia. They were prepared in a double-blind fashion by a team member who was not involved in data recording. The anesthesiologist responsible for providing anesthesia and recording heart rate and blood pressure, ophthalmologist who was recording intraocular pressure, and the patient were thus kept unaware of the content of the syringes.

All patients were premedicated with i.v. Inj.glycopyrrolate 0.2 mg and Inj.fentanyl 2 µg/kg. After preoxygenation for 5 minutes, anesthesia was induced with Inj.thiopentone 5 mg/kg, neuromuscular blockade was achieved with Inj.succinylcholine 1.5 mg/kg to facilitate endotracheal intubation. Under direct laryngoscopy trachea was intubated with appropriate size endotracheal tube, placement was confirmed by auscultation and capnography. Anesthesia was maintained using Nitrous oxide 66%, Oxygen 33%, Isoflurane and Inj.vecuronium 0.05mg/kg under mechanical ventilation. Appropriate intravenous fluids were used depending upon the surgical and the anesthetic needs. Inj.vecuronium and Inj.fentanyl were repeated as necessitated. At the end of surgery neuromuscular blockade was reversed using Inj.neostigmine 0.05 mg/kg and Inj.glycopyrrolate 0.01mg/kg and extubated as per standard protocol.

The following parameters were recorded in both the groups: intraocular pressure (IOP), heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) using GE – Datex-Ohmeda Anesthesia Monitor. IOP was measured using Schiotz indentation tonometer. The above parameters were recorded at the following time points:

1. T₁: 10 minutes before the study drug is injected (baseline).
2. T₂: 10 minutes after the administration of study drug.
3. T₃: Thirty seconds after succinylcholine is injected.
4. T₄: One minute after intubation
5. T₅: Five minutes after intubation
6. T₆: Ten minutes after intubation

Sedation was assessed using Ramsay sedation scale. Side effects like hypotension (fall in systolic blood pressure >30% of baseline),⁵⁻⁷ bradycardia (heart rate <45 beats /min),⁶ post-operative nausea, vomiting and

any other side effects were studied and treated appropriately.

Statistical Analysis

Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5 % level of significance (p< 0.05). The following assumptions on data were made - dependent variables should be normally distributed, samples drawn from the population should be random, cases of the samples should be independent.

Student t test (two tailed, independent) and Chi-square/ Fisher Exact test were used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters and categorical scale between two or more groups respectively. LevenIs test for homogeneity of variance has been performed to assess the homogeneity of variance and p≤0.01 was considered to be strongly significant.

Results

Both groups were comparable with regards to mean age, sex, weight and duration of surgery. The mean basal IOP, HR, SBP, DBP and MAP were comparable in both groups and there was no statistically significant difference (Table 1).

The mean basal IOP were comparable in both groups (p=0.508), (Table 2). Statistically significant fall in IOP was noted in Group-D, 10 minutes after study drug administration, 30 seconds after succinylcholine administration (p<0.001) compared to the control group. The increase in mean IOP was observed at 1, 5 and 10 minutes after intubation in Group-S which was statistically highly significant compared to mean IOP in group D (p<0.001), (Fig. 1).

The mean basal HR were comparable in both groups (p=0.277), (Table 3). Statistical evaluation between the groups showed a highly significant fall in HR in Group-D 10 minutes after study drug administration and 30 seconds after succinylcholine administration (p<0.001). mean HR increased after administration of succinylcholine and at 1st, 5th and 10th minute after intubation in group S was statistically highly significant compared to mean HR in Group-D (p<0.001), (Fig. 2).

The mean basal MAP were comparable in both groups (p=0.330), (Table 4). Statistically significant fall in MAP in Group-D was noted 10 minutes after study drug administration and 30 seconds after succinylcholine administration (p<0.001). The mean MAP increase observed at intubation and 1st, 5th and 10th minute after intubation in Group-S was statistically highly significant compared to mean MAP in Group-D (p<0.001), (Figure -3). In Group-D, 3 patients developed hypotension and

was managed conservatively however there was no incidence of bradycardia in both the groups.

In Group-S sedation score was 2.43 ± 0.50 and in Group-D the score was 2.47 ± 0.51 statistical evaluation no difference in the sedation score between the two groups ($p > 0.05$). In group S, none of the patients had side effects like bradycardia and hypotension. In Group-D, 3 patients had hypotension which is statistically not significant ($p = 0.237$).

Discussion

Patients with penetrating eye injury may present with full stomach. Goal of anesthesia in this scenario is to secure the airway by rapid sequence induction technique without increasing the IOP. Succinylcholine, the most commonly used muscle relaxant for rapid sequence airway management increases the IOP.⁷

Laryngoscopy and intubation are noxious stimuli and are associated with hemodynamic response in the form of laryngosympathetic stimulation, resulting in hypertension, tachycardia, arrhythmias⁸ and rise in IOP.^{5,9,10} This rise in IOP is transitory, variable and may not be significant in otherwise normal individuals. But in patients with open globe injuries of the eye it may be detrimental¹. Thus attenuation of increase in IOP and hemodynamic response to laryngoscopy and tracheal intubation, in patients undergoing ophthalmic surgeries or with raised IOP is warranted.

Various methods to attenuate the effects of succinylcholine and intubation on IOP include self-taming¹¹, pretreatment with nondepolarizing neuromuscular blocking agents,¹²⁻¹⁴ lidocaine,¹⁵ narcotics, nifedipine.¹⁶ However, no modality is devoid of drawbacks and limitations.

α_2 -agonists like clonidine¹⁷ and dexmedetomidine^{5,7,9} have been used to attenuate the rise in IOP and response to intubation, and have been found to be effective compared to all the drugs mentioned above, without any of the side effects like respiratory depression or increased incidence of PONV. Clonidine being less potent ($\alpha_1:\alpha_2=1:220$) compared to dexmedetomidine ($\alpha_1:\alpha_2=1:1620$) in its agonism to α_2 receptors¹⁸ may not be ideally suited for this purpose. Hence, dexmedetomidine may be better drug among α_2 agonists for suppressing the rise in IOP and hemodynamic responses following administration of succinylcholine, laryngoscopy and intubation.

Various authors have employed i.v. dexmedetomidine for blunting rise in IOP after succinylcholine, laryngoscopy and intubation in different doses (Table 5). Since most authors^{5,7,9} observed, 0.4 to 0.6 $\mu\text{g}/\text{kg}$ of Inj. dexmedetomidine to be effective in attenuating the rise in IOP following succinylcholine, laryngoscopy and intubation, 0.4 $\mu\text{g}/\text{kg}$ dose was chosen in our study.

In our study, in the control group, after succinylcholine there was a rise in IOP by 1.06 mm Hg above baseline which is statistically

significant ($p = 0.018$). After intubation there was statistically highly significant increase in IOP to 3.08 mm Hg above baseline ($p < 0.001$). Even at 10 minutes after intubation, the IOP remained above baseline and is statistically significant ($p = 0.039$). Our present study correlates with the studies done by Jaakola et al⁹ Pal CK et al⁷ and Mowafi et al⁵ who also found a rise in IOP following succinylcholine, laryngoscopy and intubation. After dexmedetomidine bolus, a decrease in IOP by 3.03 mm Hg in Group-D was noted which is statistically highly significant ($p < 0.001$) and remained below the baseline IOP (by 2.70 mm Hg) and is statistically highly significant ($p < 0.001$). One minute after intubation there was a rise in IOP which almost reached the baseline value and hence was not statistically significant compared to baseline IOP ($p = 0.315$). Even at 10 minutes after intubation, the IOP remained below baseline which is statistically highly significant ($p < 0.001$). Mowafi et al⁵ noted IOP in the dexmedetomidine group was lower than the baseline at all times, however immediately after intubation IOP reading was not significantly different from that at baseline, unlike that in the control group which correlates with our study. Pal CK et al⁷ also noted that IOP in the dexmedetomidine group after intubation was not significantly different from that at baseline, whereas in control group was above baseline and remained elevated even at 10 minutes after intubation. Jaakola et al⁹ observed 34 % reduction in IOP after dexmedetomidine bolus dose whereas in our study there was 17 % reduction in IOP. This is probably because Jaakola et al used 0.6 $\mu\text{g}/\text{kg}$, whereas 0.4 $\mu\text{g}/\text{kg}$ of Inj. dexmedetomidine was used in our study. Our present study correlates with the studies done by Jaakola et al,⁹ Mowafi et al⁵ and Pal CK et al,⁷ that there is a reduction in IOP in dexmedetomidine group at various time intervals.

In Group-S, mean HR at baseline, after administration of saline and Inj. succinylcholine were similar. However, statistically significant increase in HR occurred at 1st, 5th and 10th minutes after intubation ($p < 0.001$), and high even at 10th minute compared baseline. Similar findings were also noted by Aho et al²¹ (1991) and Basar et al²² in 2008. In Group-D, there was significant decrease in mean HR compared to baseline after administration of Inj. dexmedetomidine ($p < 0.001$), remained below baseline at other intervals, including at the time of intubation ($p < 0.05$) and at 1st, 5th and 10th minutes after intubation ($p < 0.001$). Mowafi et al⁵ noted a reduction in HR by 14/min, Scheinin et al²³ and Ferdi et al²⁴ noted a reduction in HR by 10/min after dexmedetomidine bolus dose, which correlates with our study. Basar et al²² noted that following laryngoscopy and intubation HR increased by 10/min in control group and whereas it decreased by 8/min from baseline in dexmedetomidine group which is statistically highly significant. The authors have observed a statistically

significant ($p < 0.05$) obtundation of heart rate response to intubation which concurs with our study.

In Group-S, variation in MAP were not noticed till intubation compared to basal values ($p > 0.05$). However, in Group-D, there was a statistically significant fall in MAP following dexmedetomidine administration by 10 mm Hg ($p < 0.001$). Ferdi et al²⁴ found a decrease in MAP by 13 mm Hg and 3 mm Hg in dexmedetomidine and control group respectively, compared to basal value before induction which concurs with our study. Basar et al²² and Mowafi et al⁵ also noted a decrease in MAP by 7 mm Hg in dexmedetomidine group which compares with our study.

MAP remained 7 mm Hg below baseline unlike the increase in MAP seen in control group (by 18 mm Hg

above baseline) which is statistically highly significant ($p < 0.001$). MAP remained below baseline even at 10th minute after intubation in dexmedetomidine group which is statistically highly significant ($p < 0.001$) compared to control group where MAP reached baseline after 10 minutes.

In group S, mean sedation score immediately after extubation was 2.43 and 2.47 in dexmedetomidine group which is statistically not significant ($p = 0.799$). In dexmedetomidine group, 3 patients developed hypotension, which was 20 minutes after drug administration. None of these patients required vasopressors for correction of hypotension and was effectively managed by decreasing volatile anesthetic concentration and infusing intravenous fluids.

Table 1: Patient characteristics (n = 30 each). Data are mean (range) or Mean \pm SD *

Time	Group-S (n=30)	Group-D (n=30)	p-value
Age (years)	42.60 (20-65)	42.63 (20-60)	0.992 (ns)
Sex (Male:Female)	16:14	16:14	1.000 (ns)
Weight (kgs)	61.07 \pm 6.23	63.37 \pm 8.17	0.225 (ns)
Mean duration of surgery (in minutes)	119.00 \pm 36.33	125.10 \pm 33.55	0.502 (ns)

Abbreviations: *SD = standard deviation, $p < 0.05$ significant, ns= statistically not significant

Table 2: Intergroup comparison of mean intraocular pressure (IOP in mm Hg) changes in response to succinylcholine and intubation between control group and dexmedetomidine group

Time	Group-S	Group-D	p-value
T1	17.89 \pm 1.63	17.56 \pm 2.14	0.508(ns)
T2	17.55 \pm 1.75	14.53 \pm 2.08	<0.001(hs)
T3	18.95 \pm 1.75	14.86 \pm 2.25	<0.001(hs)
T4	20.97 \pm 1.39	16.91 \pm 2.79	<0.001(hs)
T5	19.30 \pm 1.34	15.99 \pm 2.43	<0.001(hs)
T6	18.78 \pm 1.65	15.59 \pm 2.29	<0.001(hs)

T-time intervals as mentioned in the Methods of study. ns= statistically not significant, hs=highly significant.

Table 3: Intergroup comparison of mean heart rate (bpm) changes in response to succinylcholine and intubation between control group and dexmedetomidine group.

Time	Group-S	Group-D	p-value
T1	83.30 \pm 5.04	86.53 \pm 15.33	0.277(ns)
T2	83.67 \pm 5.47	71.37 \pm 11.90	<0.001(hs)
T3	92.40 \pm 7.55	70.80 \pm 10.94	<0.001(hs)
T4	108.87 \pm 10.78	79.07 \pm 12.65	<0.001(hs)
T5	91.17 \pm 4.53	75.33 \pm 12.55	<0.001(hs)
T6	83.77 \pm 4.88	72.97 \pm 11.40	<0.001(hs)

T-time intervals as mentioned in the Methods of study. ns= statistically not significant, hs=highly significant.

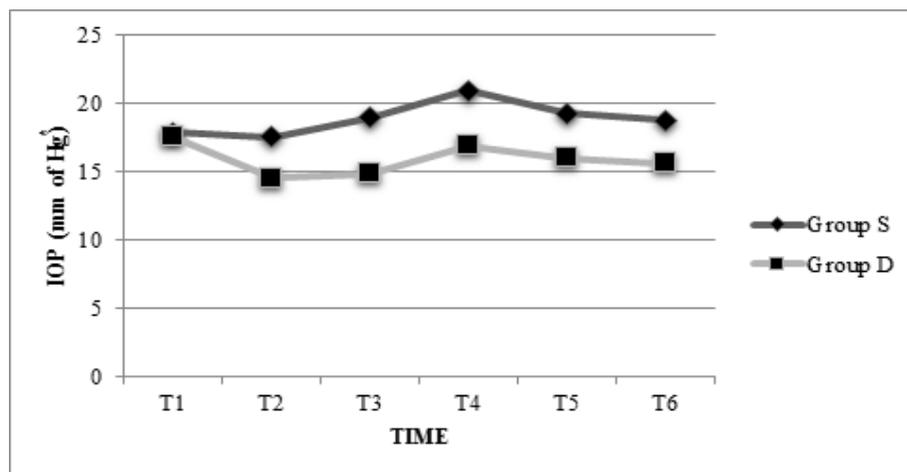
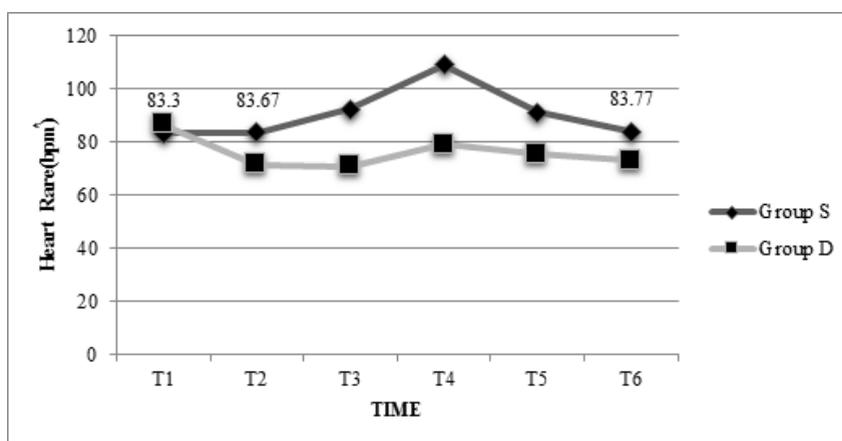
Table 4: Intergroup comparison of mean arterial pressure changes (MAP in mm Hg) in response to succinylcholine and intubation between control group and dexmedetomidine group.

Time	Group-S	Group-D	p-value
T1	95.87 \pm 6.32	97.63 \pm 7.56	0.330(ns)
T2	97.30 \pm 6.03	82.00 \pm 7.33	<0.001(hs)
T3	98.80 \pm 6.36	79.17 \pm 7.14	<0.001(hs)
T4	113.40 \pm 6.81	90.73 \pm 6.83	<0.001(hs)
T5	102.83 \pm 6.30	84.93 \pm 7.26	<0.001(hs)
T6	97.57 \pm 5.80	82.03 \pm 6.42	<0.001(hs)

T-time intervals as mentioned in the Methods of study. ns= statistically not significant, hs=highly significant.

Table 5: Dosage of dexmedetomidine employed by various authors

S. N.	Authors and year	Dose of dexmedetomidine employed
1	Jaakola et al ⁹ – 1992	0.6 µg/kg body weight i.v. over 1 minute, administered 10 minutes before induction of anesthesia.
2	Lee et al ¹⁹ – 2007	2.5 µg/kg/hr i.v. 10 minutes before induction followed by 0.4 µg/kg/hr i.v. infusion.
3	Mowafi et al ⁵ – 2008	0.6µg/kg body weight in 50 ml saline i.v. 10 minutes before induction.
4	Pal CK et al ⁷ -2011	0.4 µg/kg and 0.6 µg/kg body weight in 10 ml saline i.v. over 10 minutes before induction.
5	Xu lili et al ²⁰ – 2012	0.5 µg/kg body weight i.v. 10 minutes before Induction of anesthesia.

**Fig. 1: Intergroup comparison of intraocular pressure (IOP) changes in response to succinylcholine and intubation between control group and dexmedetomidine group, *mm of Hg = millimeters of mercury****Fig. 2: Intergroup comparison of mean heart rate changes in response to succinylcholine and intubation between control group and dexmedetomidine group, *bpm=beats per minute**

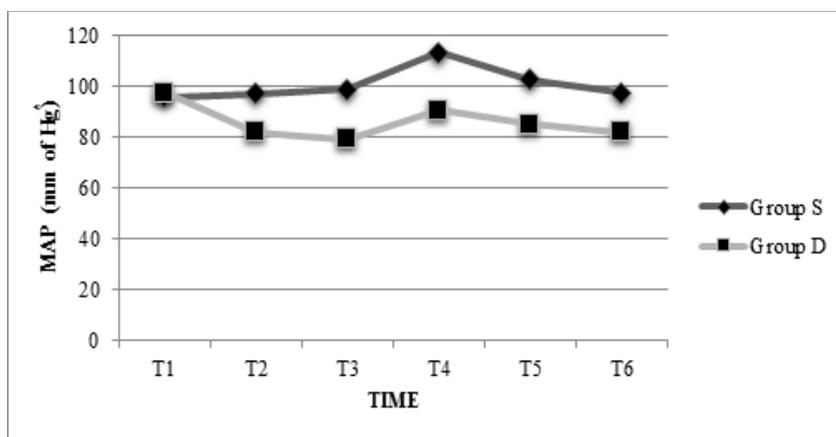


Fig. 3: Intercomparison of mean arterial pressure (MAP) changes in response to succinylcholine and intubation between control group and dexmedetomidine group, *mm of Hg = millimeters of mercury

Conclusion

Dexmedetomidine 0.4µg/kg administered intravenously 10 minutes before induction of anesthesia, significantly obtunded the rise in intraocular pressure following administration of succinylcholine and endotracheal intubation. It also attenuated the hemodynamic response to laryngoscopy and endotracheal intubation without significant side effects. Hence, it would be beneficial in patients where rise in intraocular pressure can be detrimental.

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