

Research Paper



Comparing the Effect of Propofol Versus Isoflurane on Intraocular Pressure in Laminectomy Surgeries in Prone Position

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ABSTRACT

Background and Aim: Post-operative loss of vision is not a common but dramatic complication. This is most often reported after spinal and cardiac surgeries. Ischemic optic neuropathy is the primary cause, but its etiology remains unclear. Retinal blood perfusion depends on mean arterial pressure and intraocular pressure (IOP). In spinal surgery, both of these can be altered by the type of prone-position surgery. Because different anesthetic agents can be used for anesthesia in spine surgery, we conducted this randomized clinical trial to compare the effects of propofol and isoflurane as maintenance anesthesia on IOP during spinal surgery in the prone position.

Methods and Materials/Patients: IOP was measured with the Tonopen Richert device in five steps before and after induction of anesthesia and during surgery every 30 minutes. A total of 72 patients were enrolled in this study.

Results: IOP decreased after induction of anesthesia with propofol, but significantly increased in patients receiving isoflurane as maintenance of anesthesia in a prone position compared with the propofol group. Systolic and diastolic blood pressure and duration of surgery in a prone position were also associated with increased IOP.

Conclusion: The present study showed that the group under anesthesia with propofol had significantly lower IOP than the group anesthetized with isoflurane.

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Highlights

- Intraocular pressure significantly increased during prone-position laminectomy in patients receiving isoflurane.
- Propofol maintained significantly lower intraocular pressure than isoflurane during prone-position surgery.
- The difference in intraocular pressure between the two anesthetic groups became significant at 30 and 60 minutes after prone positioning.
- Longer duration of anesthesia in the prone position was associated with increased intraocular pressure.
- Propofol may be preferable for patients at risk of elevated intraocular pressure during prolonged spine surgery.

Plain Language Summary

Postoperative vision loss (POVL) is a rare but serious complication that may occur after spine surgery, particularly when patients remain in the prone position for a long time. One factor that may contribute to this problem is an increase in intraocular pressure, which can reduce blood flow to the optic nerve. This study compared the effects of propofol and isoflurane on intraocular pressure in 72 patients undergoing laminectomy surgery in the prone position. Intraocular pressure was measured before and after induction of anesthesia, after intubation, and at 30 and 60 minutes after prone positioning. The results showed that intraocular pressure remained relatively stable in patients receiving propofol but increased progressively in those receiving isoflurane. At both 30 and 60 minutes in the prone position, intraocular pressure was significantly higher in the isoflurane group. These findings suggest that propofol may be a more appropriate anesthetic option for maintaining lower intraocular pressure during prolonged spine surgery, particularly in patients who are at increased risk of elevated intraocular pressure or visual complications.

1. Introduction

Although postoperative vision loss (POVL) is not common, it is a dramatic complication reported more often after cardiac and spinal surgeries in the prone position, and depending on the type of surgery, it can occur from 0.01% to 1%. [1-5]. In recent years, cases of POVL with non-ophthalmic surgery have been frequently reported [6-8]. Many studies have indicated that surgeries, especially prolonged prone positioning and/or hypotensive anesthesia, can induce changes in intraocular pressure (IOP) and an imbalance ocular perfusion [9, 10]. Many causes have been described for perioperative visual loss, including central retinal artery occlusion, anterior ischemic optic neuropathy (ION), posterior ischemic optic neuropathy, cortical blindness, and acute glaucoma. Among these, ION is the most cited cause [1-5] although its predisposing factors are not well defined and understood yet. Underlying diseases, such as diabetes mellitus, high or very low blood pressure during operation, atherosclerosis, large volume of blood loss, and need for large volume of intravascular fluids replacement (hemo-dilution), and the position

of the patient (prone and head down with risk of eye compression against headrest can play a crucial role in the development of such devastating complications [11-19]. Ocular perfusion pressure is expressed as the difference between mean arterial pressure and IOP. Therefore, changes in each of them can play a role in the perfusion of the optic nerve. The prone position is considered a risk factor for IOP changes and the development of ION due to decreased venous return, therefore, an increased IOP greater than 24 mm Hg has a negative effect on perfusion of the optic nerve perfusion and puts patients at risk of visual damage [20]. The risk of vision loss following spine surgery in the prone position is 0.05% [2]. Drugs used in anesthesia can also affect IOP changes, but controversial results have been reported from different anesthetic agents on IOP. Due to the existence of conflicting results regarding the effects of anesthetic drugs on intraocular pressure, this study aimed to investigate the effects of propofol and isoflurane on IOP changes in the prone position during laminectomy surgery and to prevent postoperative visual damage by specifying the preferred method of anesthesia.

2. Methods and Materials

A study was conducted on 72 patients as candidates for laminectomy spine surgery in the prone position. The inclusion criteria are as follows: Age over 18 years, candidate for elective laminectomy (lumbar spine surgery) without medical history of glaucoma or corneal disease, and no history of allergy to Tetracaine eye drops. Subjects were included in the study after obtaining written consent. In case of using diuretic drugs, such as mannitol or inotropic drugs infusion, such as noradrenaline, and poor or uncontrolled blood pressure ($BP \geq 160/110$) at the beginning of surgery, patients were excluded from the study. Laminectomy candidate patients in the prone position under a random block were included in one of the anesthetic methods, including propofol and isoflurane. After receiving 3 $\mu\text{g/kg}$ of fentanyl and 0.02 mg/kg of midazolam as premedication, induction of anesthesia was performed with 1.5 mg/kg of propofol and 0.5 mg/kg of atracurium as a neuromuscular blocking agent. Intubation was performed under direct laryngoscopy with an appropriate size Macintosh laryngoscope blade and a tracheal tube 7.5 to 8 mm internal diameter. The tracheal tube was fixed with adhesive tape to avoid jugular vein obstruction. In the propofol group, intravenous propofol with dioxygen (O_2) plus nitrous oxide (N_2O) at 50% was used, and in the isoflurane group, inhaled isoflurane with a 50% $\text{O}_2/\text{N}_2\text{O}$ mixture was used as the anesthetic method. Bispectral index (BIS): 40-60 was the target depth of anesthesia. Closed circuit system of mechanical ventilation using Soda lime as carbon dioxide (CO_2) absorbing agent and lungs ventilated with tidal volume: 8-10 ml/kg, zero end expiratory pressure, respiratory rate: 10-14/min, and end tidal CO_2 remained in the range of: 35-40 mm Hg. The prone position of the patients was performed by using two rolls for the chest and hips and a headrest, so that the forehead and chin were placed in a neutral position at 0° to the trunk, and any direct pressure on the

eyes was avoided. Systolic and diastolic blood pressure were measured and recorded by the monitoring device every 5 minutes, and IOP in patients was measured with the Tonopen Richert in 5 stages. Step 1: Supine-before induction of anesthesia (baseline) Step 2: Supine-after induction of anesthesia Step 3: supine - after intubation Step 4: Prone-30 minutes after induction of anesthesia (prone 30) Step 5: Prone-60 minutes after induction of anesthesia (prone 60).

3. Results

In this study, 34 patients in the propofol group and 38 patients in the isoflurane group, a total of 72 cases, were examined. The mean age in the propofol group was 48.4 ± 16.6 , and in the isoflurane group was 44.7 ± 15.4 . These two groups showed no statistically significant differences in age or anthropometric indices (Table 1). Before induction of anesthesia, no statistically significant difference in intraocular pressure was observed between the two groups of propofol and isoflurane (Table 2).

The average IOP in the group propofol at the beginning of surgery as baseline IOP was 18.26 ± 2.71 , which decreased to 17.59 ± 3.9 at the end of surgery in the prone position. Based on a repeated-measure analysis, this trend of change was not statistically significant ($P=1$). On the other hand, the average baseline IOP in group isoflurane was 19.45 ± 3.7 in the prone position surgery with isoflurane anesthesia. IOP gradually increased to 22.84 ± 5.18 at the end of the surgery; this trend was statistically significant ($P=0.014$). Compared with the propofol group, the independent paired t-test, the intraocular pressure of patients under anesthesia with isoflurane in the prone position at the 30th and 60th minutes after induction of anesthesia was significantly higher than that of the propofol group ($P=0.001$) (Figure 1).

Table 1. Demographic data of two groups (propofol vs isoflurane)

Group	No. /Mean $\pm$ SD		P
	Propofol (n=34)	Isoflurane (n=38)	
Gender (M/F)	19/5	12/26	
Age (y)	48.4 ± 16.65	44.71 ± 15.42	0.331
Height (cm)	165 ± 10.14	171.03 ± 11.38	0.324
Weight (kg)	71.9 ± 12.44	71.03 ± 11.38	0.753

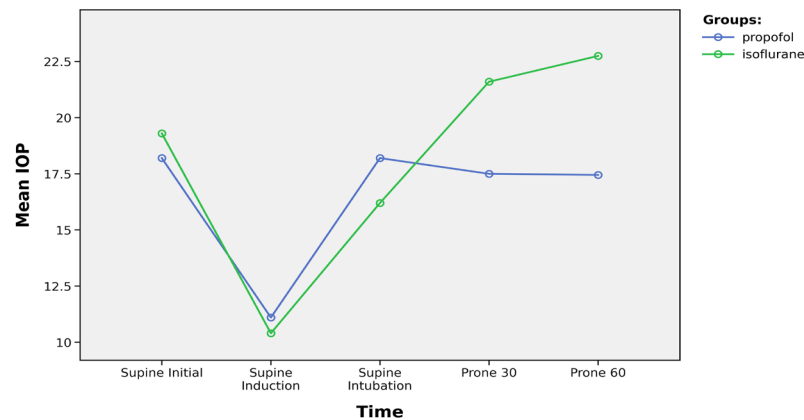


Figure 1. IOP changes in different phases of anesthesia: Baseline, after induction of anesthesia, and in 30-minute intervals after prone position in two groups ($P=0.032$)

The systolic and diastolic blood pressures at baseline in both groups were almost identical, with no significant difference. According to the repeated-measures analysis test, no statistically significant difference in systolic blood pressure was observed between the two groups ($P=0.032$). For diastolic blood pressure, the same was true between the two groups ($P=0.145$) (Table 3).

Only in the stages of intubation, the systolic and diastolic blood pressure, and in the induction stage, the diastolic blood pressure of the propofol group was significantly higher than that of the isoflurane group. Figures 2 and 3 show the trends of these changes.

To investigate the effect of propofol and isoflurane anesthesia maintenance methods on IOP, data related to the right and left eyes were merged, and by controlling fixed demographic variables, such as age, weight, and height, as well as variables, such as systolic blood pressure and diastolic blood pressure, a generalized linear model was used by the generalized estimating equations method. Therefore, the propofol group had lower intraocular pressure than the isoflurane group. (1.5 ± 0.05) Also, women showed lower IOP than men. (0.25 ± 1). A significant decrease in IOP values was also observed with increasing age ($P=0.0001$). With increasing anesthesia duration in the prone position, IOP increased ($P=0.0001$). In

Table 2. IOP changes in different phases of anesthesia: baseline, after induction of anesthesia, and in 30-minute intervals after prone position in two groups

IOP	Mean $\pm$ SD		P
	Propofol (n=34)	Isoflurane (n=38)	
Baseline IOP OD	18.26 $\pm$ 2.71	19.45 $\pm$ 3.7	0.130
Baseline IOP OS	18.21 $\pm$ 2.79	19.21 $\pm$ 3.7	0.202
After induction IOP OD	11.44 $\pm$ 3.3	10.39 $\pm$ 2.94	0.160
IOP OS	10.85 $\pm$ 2.81	10.42 $\pm$ 2.96	0.530
After intubation IOP OD	18.41 $\pm$ 4.69	16.18 $\pm$ 5.08	0.059
After intubation IOP OS	17.94 $\pm$ 4.43	16.11 $\pm$ 5.9	0.144
30 min in prone IOP OD	17.62 $\pm$ 3.61	21.66 $\pm$ 5.25	0.001
30 min in prone IOP OS	17.44 $\pm$ 3.06	21.5 $\pm$ 5.41	0.001
60 min in prone IOP OD	17.59 $\pm$ 3.9	22.84 $\pm$ 5.68	0.001
60 min in prone IOP OS	17.38 $\pm$ 3.86	22.63 $\pm$ 6.44	0.001

Abbreviations: IOP: Intraocular pressure; OD: Oculus dexter; OS: Oculus sinister.

Table 3. Hemodynamic changes in different phases of anesthesia: baseline, after induction of anesthesia, and at 30-minute intervals after prone position in two groups

Groups		Mean±SD		P
		Propofol (n=34)	Isoflurane (n=38)	
Baseline	SBP	130.53±22.48	138.16±24.54	0.175
	DBP	84.85±14.57	88.66±18.07	0.303
After induction	SBP	113.76±24.12	103.79±21.5	0.068
	DBP	74±18.55	63.5±16.78	0.014
After intubation	SBP	133.53±22.38	120.11±24.83	0.019
	DBP	91.41±16.01	79.63±17.78	0.004
30 min prone	SBP	112.94±16.9	113.66±15.88	0.853
	DBP	75.76±11.47	76.66±14.9	0.778
60 min prone	SBP	113.85±16.6	113.47±17.4	0.925
	DBP	76.82±12.25	77.74±16.6	0.793

SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

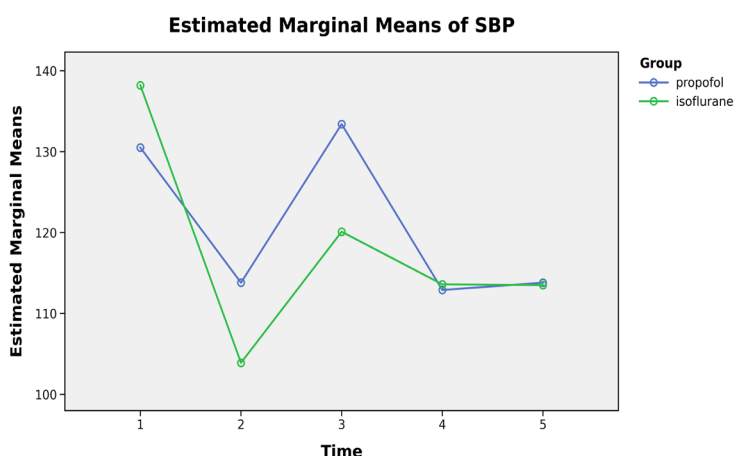


Figure 2. Estimated marginal means of systolic blood pressure (P=0.032)

group I, this increase in IOP was progressive until the 60th minute of anesthesia, whereas in the propofol group, it reached a steady state from the 30th minute to the end of surgery. The effects of body mass index on intraocular pressure were not significant. IOP also increased significantly with increasing systolic blood

pressure (P=0.0001). For every 1 mm Hg increase in systolic blood pressure, IOP increased by 0.005±0.078. The same was true for diastolic blood pressure, so that for every 1 mm Hg increase in diastolic blood pressure, IOP increased by 0.007±0.015.

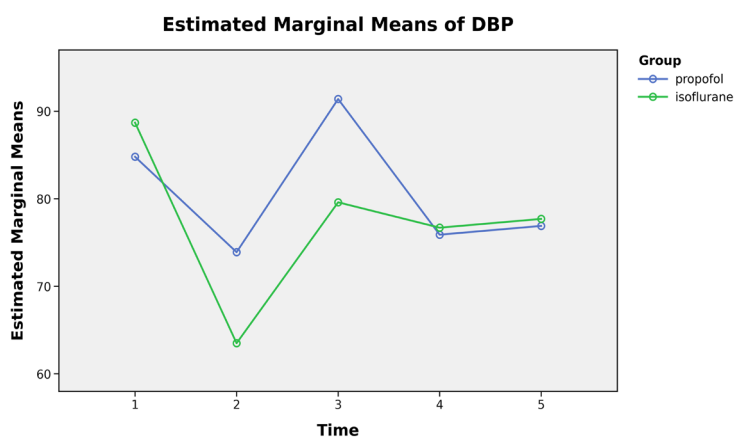


Figure 3. Estimated marginal means of diastolic blood pressure (P=0.145)

4. Discussion

POVL is a rare but devastating complication that has been reported after spine surgeries. ION is most frequently associated with lumbar operations. Possible factors of perioperative ION include decreased systemic blood pressure, blood loss, anemia or hemodilution; altered venous hemodynamics, flow of cerebrospinal fluid in the optic nerve, abnormal autoregulation in the optic nerve, anatomic variants in blood supply to the optic nerve; small cup-to-disc ratio, and the use of vasopressors. The systemic vascular risk factors include hypertension, diabetes, atherosclerosis, hyperlipidemia, and smoking history, prone positioning, lengthy surgery for spinal fusion, and other preexisting systemic abnormalities, such as sleep-apnea syndrome and hypercoagulability [21, 22, 3].

Also, Sun et al. [23] showed that IOP in both eyes in the prone position before leaving the operating room was significantly higher than IOP 10-min after anesthesia ($P<0.01$). Anesthesia induction with midazolam, propofol, fentanyl, and cis-atracurium had direct or indirect effects on IOP lowering [24].

In another study, the effect of two drugs, propofol and isoflurane, and also propofol and sevoflurane, on IOP changes was investigated, but no statistically significant difference was observed between the two drugs, in operations other than the prone position, such as spinal surgery, a difference was observed [25, 26].

The effect of the prone position on increasing intraocular pressure has been proven before [27, 28].

Also, in Sugata's study, propofol and isoflurane did not differ significantly in reducing intraocular pressure during spine surgery in the prone position [29].

The present study showed that the group under anesthesia with propofol had significantly lower IOP than the group anesthetized with isoflurane ($P=0.001$).

Previously, Leveque reported that intraocular pressure in patients receiving propofol was significantly lower than in those receiving compared to isoflurane [30-32]. Buenhner in 2011 investigated the effects of propofol and isoflurane on IOP changes in pigs and found that animals anesthetized with isoflurane had higher intraocular pressure than the propofol group [33]. In a similar study in the supine position for laparoscopic surgery, patients in the propofol group had lower IOP than those in the isoflurane group. Also, Mowafi did not

find a relationship between increased blood pressure and IOP [34]. In our study, systolic and diastolic blood pressure between the propofol and isoflurane groups did not differ significantly. Similar to our study, Sugata et al. reported changes in IOP during prone spine surgery under propofol and sevoflurane anesthesia. By analyzing existing data, the authors found that intraocular pressure increases with increasing duration of anesthesia in a prone position. This study showed that increased systolic and diastolic blood pressure is associated with increased intraocular pressure.

This study had some limitations, such as the fact that the study was conducted in a single-blind manner, and the researcher was aware of the anesthesia maintenance protocol.

5. Conclusion

Considering the results during anesthesia in the prone position, propofol resulted in a significantly lower IOP, and the changes during operation were steeper in patients who received inhalational isoflurane. As the effect of the prone position on IOP is evident, and in the absence of obvious external compression of the eye, POVL and IOP appear to be multifactorial problems with no consistent underlying mechanism. For patients at risk or with a history of high IOP, such as acute angle glaucoma, especially in prolonged and complex spinal surgery with a huge volume of bleeding and intravascular fluid, the authors recommend choosing propofol as the induction and maintenance agent of anesthesia. Future studies evaluating other anesthetic agents are recommended.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Research Ethics Committee of [Guilan University of Medical Sciences](#), Rasht, Iran (Code: IR.GUMS.REC.1397.246), and was registered and approved in the [Iranian Registry of Clinical Trials \(IRCT\)](#), Tehran, Iran (Code: IRCT20140310016917N7).

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Authors' contributions

All authors contributed equally to the conception and design of the study, data collection and analysis, interception of the results and drafting of the manuscript. Each author approved the final version of the manuscript for submission.

Conflict of interest

The authors declared no conflict of interest.

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