INTRODUCTION

General anesthesia is known to cause increase in intraocular pressure (IOP) secondary to hemodynamic stress response such as hypertension, hypercarbia, or due to effects of anesthetic agents. Lower abdominal surgeries, especially laparoscopic surgeries, require steep Trendelenburg position, and during robotic pelvic surgeries, the demand for head low position is even greater. This may result in an unacceptable rise in IOP with increased risk of postoperative visual loss in susceptible patients.1 The use of a restrictive intravenous fluid administration as compared to liberal fluid administration has been shown to result in better patient outcome and shorter hospital stay.3 We hypothesized that adopting a restrictive intravenous fluid strategy intraoperatively could blunt rise in IOP associated with steep Trendelenburg position.

Aim of the study

The primary objective of our study was to compare the changes that occur in IOP during robotic pelvic surgeries in steep Trendelenburg position with restrictive fluid administration. The secondary objectives included the assessment of correlation of IOP with changes in hemodynamics, end-tidal carbon dioxide, and peak airway pressures intraoperatively.

Subjects and Methods

The present study was a prospective observational study conducted after obtaining Institutional Ethical Committee clearance. Twenty consenting patients scheduled for pelvic robotic gynecological surgeries were enrolled in this study. Patients of both sexes aged 18–60 years of the American

Background: Robotic pelvic surgeries require steep Trendelenburg position which may result in rise in intraocular pressure (IOP).

Aim: The aim of this study was to compare the changes that occur in IOP during robotic pelvic surgeries in steep Trendelenburg position with a restrictive intravenous fluid administration.

Settings and Design: This prospective observational study was conducted in a tertiary care institution.

Subjects and Methods: Twenty consenting patients scheduled for pelvic robotic gynecological surgeries were enrolled. All patients received general anesthesia following a standardized protocol. IOP was measured before induction of anesthesia, immediately after induction and intubation, at the end of surgery immediately after making the patient supine and immediately after extubation. Ringer’s lactate was administered intravenously at a rate of 4 mL/kg/h targeting a mean arterial pressure of >65 mmHg and urine output of >0.5 mL/kg/h.

Statistical Analysis Used: Paired t-test was used in this study.

Results: There was a fall in IOP soon after induction from baseline which was not significant. Immediately, following intubation, there was a significant rise in IOP. At the end of surgery, though IOP remained high, it was not statistically significant. However, following extubation, IOP rose further and the difference from the baseline became statistically significant. Although there was a moderate increase in peak airway pressure and highest EtCO₂ levels during Trendelenburg from baseline values, the differences were statistically insignificant.

Conclusion: During robotic pelvic surgeries, adopting a restrictive intravenous fluid strategy with the maintenance of normal end-tidal carbon dioxide levels could abate effects of steep Trendelenburg position on IOP.

Keywords: End-tidal carbon dioxide, intraocular pressure, restrictive fluid, robotic surgery, Trendelenburg

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Access this article online

Quick Response Code:  
Website: www.aeronline.org  
DOI: 10.4103/aer.AER_144_17

How to cite this article: Tosh P, Krishnankutty SV, Rajan S, Nair HM, Puthanveettil N, Kumar L. Does restrictive fluid strategy during robotic pelvic surgeries obtund intraoperative rise in intraocular pressure? Anesth Essays Res 2018;12:155-8.
Society of Anesthesiologists physical status 1–3 were selected. Those with history of or existing glaucoma, uncontrolled hypertension, pheochromocytoma, and hyperthyroidism were excluded from the study.

After a detailed preanesthetic assessment patients were kept fasting 6 h for solids and 4 h for fluids. Alprazolam 0.5 mg, ranitidine 150 mg, and metoclopramide 10 mg were administered orally to all patients on the night before surgery. On the day of surgery, in the operation theater, a large-bore intravenous cannula was introduced and preinduction monitors such as electrocardiogram, pulse oximeter, and noninvasive blood pressure monitors were attached. In the supine position, eyes of the patients were anesthetized with 4% topical lignocaine, and intravenous glycopyrrolate 0.2 mg, fentanyl 2 µg/kg, and midazolam 2 mg intravenously were administered. After 3 min of preoxygenation, patients were induced with propofol 2–2.5 mg/kg and were intubated with an appropriate sized endotracheal tube 3 min following vecuronium 0.1 mg/kg. Anesthesia was maintained with isoflurane in oxygen-air mixture (1:2). Delivery of isoflurane was adjusted so as to maintain an end-tidal concentration of 1 MAC. The respiratory rate and tidal volume in the ventilator were adjusted so as to maintain end-tidal carbon dioxide levels of 30–35 mmHg and peak airway pressure <26 cm of H2O.

Ringer’s lactate was administered intravenously at a rate of 4 mL/kg/h targeting a mean arterial pressure (MAP) of >65 mmHg and urine output of >0.5 mL/kg/h. Intraoperative rises in heart rate (HR) or MAP to >20% from the baseline values were managed with additional doses of fentanyl 20 µg after increasing the volatile agent concentration to 1.5%–2% for 3–5 min. Reduction in MAP below 65 mmHg was initially managed with fluid bolus of 200 mL of Ringer’s lactate. If there was no adequate response, intravenous phenylephrine 50 µg was used as bolus and need for more than three boluses in 15 min warranted initiation of noradrenaline infusion. Dose of phenylephrine used and need for vasopressors were documented.

Additional analgesia was given with paracetamol 1 g intravenously over 20 min after the first 500 mL of intravenous fluid. Toward the end of surgery, anesthetic gasses were discontinued and patients were extubated after reversing neuromuscular blockade and awake with return of protective airway reflexes.

IOP was measured by an ophthalmologist under topical anesthesia before induction of anesthesia, immediately after induction and intubation, at the end of surgery immediately after making the patient supine and immediately after extubation. IOP was measured using a tonopen on both eyes of the patients. HR and MAPs were recorded at the above-mentioned time points and at 30 min interval intraoperatively. Peak airway pressures and end-tidal carbon dioxide levels were also documented half hourly. The degree of Trendelenburg tilt of the operating table during robotic procedure was kept at 30°.

Paired t-test was used to compare the change of measurements at different time points from the baseline. Statistical analyses were done using SPSS version 20.0 for Windows (IBM Corporation, ARMONK, NY, USA).

**RESULTS**

Mean age of patients was 30.5 ± 9.7 years with a body mass index of 27.2 ± 3.8. The baseline mean IOP of both eyes (14.62 ± 2.91 and 14.24 ± 4.88) was compared to subsequent IOP at different time points. It was shown that there was a fall in IOP soon after induction in both eyes from baseline which was not significant. Immediately, following intubation, there was a significant rise in IOP ($P < 0.001$). At the end of surgery, though IOP remained high, it was not statistically significant. However, following extubation, IOP rose further and the difference from the baseline became statistically significant ($P = 0.001$ and 0.005, Table 1 and Figure 1).

There was a fall in HR and MAP from baseline after induction with a significant rise during intubation. MAP was lower than baseline at the end of surgery with a higher HR, but the difference was insignificant. At extubation, though there was an increase in both HR and MAP, the rise was statistically significant only with MAP (Figure 2).

The median duration of surgery and Trendelenburg position and the intravenous fluid administered were 240 min, 200 min, and 800 mL, respectively. Although there was a moderate increase in peak airway pressure and highest EtCO2 levels during Trendelenburg from baseline values (18.9 ± 2.9 vs. 22.8 ± 2.5 cm of H2O and 30.6 ± 2.5 vs. 33.2 ± 4.5 mmHg, $P > 0.05$), the difference was statistically insignificant [Table 2]. No patient needed vasopressors or inotropes for the maintenance of MAP above 65 mmHg.

**DISCUSSION**

Perioperative fluid administration is a highly debated topic. Maintaining an effective circulating volume is vital for optimal organ perfusion. Fluid overloading and dehydration both have detrimental effects in organ systems which ultimately affect

| Table 1: Changes in intraocular pressure |
|-----------------------------------------|
| **Time** | **Mean±SD** | **Mean difference from baseline** | **$P$** |
|-----------------------------------------|
| **Right eye** | **Baseline** | 14.62±2.91 | | |
| | Postinduction | 13.43±2.94 | −1.19 | 0.053 |
| | Postintubation | 22.14±4.13 | 7.52 | <0.001 |
| | End of surgery | 16.57±2.77 | 1.95 | 0.066 |
| | Postextubation | 18.05±3.38 | 3.43 | 0.001 |
| **Left eye** | **Baseline** | 14.24±4.88 | | |
| | Postinduction | 13.57±5.16 | −0.67 | 0.090 |
| | Postintubation | 21.76±4.24 | 7.52 | <0.001 |
| | End of surgery | 15.52±2.84 | 1.29 | 0.283 |
| | Postextubation | 18.33±3.29 | 4.1 | 0.005 |

SD=Standard deviation
the patient outcome. One of the inherent risks of liberal fluid administration is inadvertent intravascular fluid expansion which can result in increases in IOP.

Increase in IOP under general anesthesia is multifactorial. Anesthetic agents such as ketamine and succinylcholine are known to cause rise in IOP. The integral procedures during general anesthesia such as laryngoscopy and intubation are invariably associated with hemodynamic stress responses. Unless specific pharmacological measures are adopted to attenuate these effects, it will, in turn, result in an increase in the IOP.

Other compounding factors which result in elevated IOP are bucking, hypoxia, acute hypertension, excessive transfusion, intraoperative hypercarbia, Trendelenburg or prone position. During laparoscopic surgeries, need for steep head low position, carbon dioxide insufflation with possible hypercarbia along with increased intra-abdominal pressure poses an exaggerated risk of rise in IOP. Rises in IOP more than ocular perfusion as choroidal blood flow decreases which may later present as postoperative visual loss.

Significant elevations of IOP are documented during laparoscopic surgery in steep head low position even in patients with healthy eyes and hence, the potential risk to those with known ocular disease could be devastating. IOP increases in a time-dependent manner in these cases, and hence, it is argued that steep Trendelenburg positioning during time-limited procedures appears to pose little or no risk from IOP increases in patients without preexisting ocular disease. The maximum rise in IOP is observed at the end of the steep Trendelenburg position with an average rise in IOP of 13 mmHg from the preinduction value. The duration of surgery and the end-tidal carbon dioxide levels are the significant predictors of IOP rise in this patient position.

In patients with normal IOP, following robotic-assisted radical prostatectomy in a steep Trendelenburg position, no significant deterioration was observed in the visual functions postoperatively. However, those with a history of glaucoma and marginally elevated IOP who may look apparently normal, the margin of safety during these procedures could be narrow. There is a theoretical risk of vision loss from a transient and significant increase in IOP during robotic surgery in this subset of patients.

In the present study, we observed that there was a fall in IOP soon after induction which paralleled the fall in hemodynamic parameters. The highest rise in IOP occurred during intubation. During surgery, though a very steep head low was provided, the increase in IOP was never as high as during intubation. The reasons could be multifactorial. The use of a restrictive fluid strategy along with maintenance of near normal end-tidal carbon dioxide might have negated the effects of steep head low and moderate rise in peak airway pressures on IOP. From our study, it is evident that the events which cause greatest rise in IOP during laparoscopic surgery are intubation and extubation provided EtCO₂ and peak airway pressures are maintained in acceptable limits. As the key factor which results in rise in IOP such as venous congestion secondary to high airway pressure, hypercarbia, or hypertension, other than a steep head low position, was not observed during the procedure, it can be elucidated that the restrictive fluid strategy

| Variables                        | Median | Minimum | Maximum |
|----------------------------------|--------|---------|---------|
| Volume of IV fluid used (mL)     | 800.0  | 350     | 5500    |
| Duration of surgery (min)        | 240.0  | 120     | 3600    |
| Duration of Trendelenburg position (min) | 200.0  | 75      | 3540    |

| Variables                  | Mean±SD | P        |
|----------------------------|---------|----------|
| Baseline peak airway pressure | 18.9±2.9 | 0.067    |
| Maximum intraoperative peak airway pressure | 22.8±2.5 |         |
| Baseline EtCO₂             | 30.6±2.5 | 0.163    |
| Maximum intraoperative EtCO₂ | 33.2±4.5 |         |

SD=Standard deviation
might have prevented a rise in IOP due to Trendelenburg position.

In the aging risk for glaucoma is significant, hence, a preoperative ophthalmic assessment should be made mandatory to identify an occult disease in those who are planning to undergo lower abdominal laparoscopic surgery. In those with increased risk of the development of glaucoma, frequent perioperative assessment of IOP should be warranted and topical administration of dorzolamide-timolol intervention for rising IOP to >40 mmHg during steep Trendelenburg is recommended. In general, any postoperative patient with complaints of red eyes, visual disturbances, eye pain, headache, and nausea should undergo a timely examination by an ophthalmologist as all patients should be considered at risk of acute angle-closure glaucoma.

Pelvic robotic surgeries usually require a restrictive intravenous fluid strategy to aid pelvic node dissection around partially collapsed veins, but these patients postoperatively often need fluid boluses to correct the volume depletion to maintain urine output as well as normal hemodynamics. The major limitation of the present study was that we adopted restrictive fluid strategy based only on the maintenance of MAP and urine output. Cardiac output and tissue oxygen delivery were not monitored intraoperatively.

**CONCLUSION**

During robotic pelvic surgeries, adopting a restrictive intravenous fluid strategy with maintenance of normal end-tidal carbon dioxide levels could abate effects of steep Trendelenburg position on IOP.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**

1. Molloy BL. Implications for postoperative visual loss: Steep Trendelenburg position and effects on intraocular pressure. AANA J 2011;79:115-21.
2. Bleier JI, Aarons CB. Perioperative fluid restriction. Clin Colon Rectal Surg 2013;26:197-202.
3. Gayat E, Gabinson E, Devys JM. Case report: Bilateral angle closure glaucoma after general anesthesia. Anesth Analg 2011;112:126-8.
4. Chandra A, Ranjan R, Kumar J, Vohra A, Thakur VK. The effects of intravenous dexametomidine premedication on intraocular pressure and pressor response to laryngoscopy and intubation. J Anaesthesiol Clin Pharmacol 2016;32:198-202.
5. Sarkar A, Tripathi RK, Choubey S, Singh RB, Awasthi S. Comparison of effects of intravenous clonidine and dexametomidine for blunting pressor response during laryngoscopy and tracheal intubation: A randomized control study. Anesth Essays Res 2014;8:361-6.
6. Rajan S, Krishnankutty SV, Nair HM. Efficacy of alpha2 agonists in obtundion rise in intraocular pressure after succinylcholine and that following laryngoscopy and intubation. Anesth Essays Res 2015;9:219-24.
7. Gainsburg DM. Anesthetic concerns for robotic-assisted laparoscopic radical prostatectomy. Minerva Anestesiol 2012;78:596-604.
8. Mondezelewski TJ, Schmitz JW, Christman MS, Davis KD, Lujan E, L’Esperance JO, et al. Intraocular pressure during robotic-assisted laparoscopic procedures utilizing steep Trendelenburg positioning. J Glaucoma 2015;24:399-404.
9. Hoshikawa Y, Tsutsumi N, Ohkoshi K, Serizawa S, Hamada M, Inagaki K, et al. The effect of steep Trendelenburg positioning on intraocular pressure and visual function during robotic-assisted radical prostatectomy. Br J Ophthalmol 2014;98:305-8.
10. Borahay MA, Patel PR, Walsh TM, Tarnal V, Koutrouvelis A, Vizzeri G, et al. Intraocular pressure and steep Trendelenburg during minimally invasive gynecologic surgery: Is there a risk? J Minim Invasive Gynecol 2013;20:19-24.
11. Awad H, Walker CM, Shaikh M, Dimitrova GT, Abaza R, O'Hara J. Anesthetic considerations for robotic prostatectomy: A review of the literature. J Clin Anesth 2012;24:494-504.
12. Awad H, Santilli S, Ohr M, Roth A, Yan W, Fernandez S, et al. The effects of steep Trendelenburg positioning on intraocular pressure during robotic radical prostatectomy. Anesth Analg 2009;109:473-8.
13. Awad H, Malik OS, Cloud AR, Weber PA. Robotic surgeries in patients with advanced glaucoma. Anesthesiology 2013;119:954.
14. Molloy B, Cong X. Perioperative dorzolamide-timolol intervention for rising intraocular pressure during steep Trendelenburg positioned surgery. AANA J 2014;82:203-11.
15. Nitta Y, Kamekura N, Takuma S, Fujisawa T. Acute angle-closure glaucoma after general anesthesia for bone grafting. Anesth Prog 2014;61:162-4.
16. Hsa RL, Kaye AD, Urman RD. Anesthetic challenges in robotic-assisted urologic surgery. Rev Urol 2013;15:178-84.