Intraocular pressure (IOP) more reduced when using TIVA with propofol during robot-assisted laparoscopic radical prostatectomy

Eunkyeong Choi

Department of Medicine

The Graduate School, Yonsei University

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Directed by Professor Sun-Joon Bai

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Eunkyeong Choi

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This certifies that the Master's Thesis of

Eunkyeong Choi is approved.

Thesis Supervisor: Sun-Joon Bai

Thesis Committee Member#1: Young Jun Oh

Thesis Committee Member#2: Chan Yun Kim

The Graduate School
Yonsei University

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<TABLE OF CONTENTS>

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

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Eunkyeong Choi

Department of Medicine or Medical Science
The Graduate School, Yonsei University

(Directed by Professor Sun-Joon Bai)

Intraocular pressure (IOP) is significantly increased during robot-assisted laparoscopic radical prostatectomy (RLRP) which is performed in a steep Trendelenburg position at prolonged times of pneumoperitoneum (PP). Patients undergoing RLRP are often old aged with various comorbities and tend to be vulnerable to postoperative vision loss. Commonly used anesthetics are known to decrease IOP. This prospective randomized study was done to compare the effect of propofol-based total intravenous anesthesia (TIVA) and sevoflurane-based balanced anesthesia on the IOP of elderly patients undergoing RLRP. 66 male patients were randomly assigned to either the control group or the TIVA group with propofol. IOPs were measured at nine different time points. IOP was significantly increased in the control group at T3 (30 min after steep Trendelenburg position), T4 (5 min after returning to horizontal position), and T6 (5 min after tracheal extubation) when compared to the TIVA group with propofol. IOP was significantly lower in the TIVA group

compared to the control group at T2 (5 min after PP), T3, and T6. We could confirm that TIVA with propofol was more effective in preventing the increase in IOP caused by PP and steep Trendelenburg position compared to the control group with sevoflurane. TIVA with propofol may beneficial in patients who are at increased risk of ocular complications due to increased IOP during and after RLRP.

Key words: intraocular pressure, robot-assisted surgery, Trendelenburg, propofol

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I. INTRODUCTION

Postoperative vision loss (POVL) in non-ophthalmic surgeries is reported to be a rare complication but could be disastrous to the patient. The incidence of POVL after non-ophthalmic surgery is estimated to be as low as 0.013% to as high as 0.2% depending on different previous studies.[1] Although the exact pathogenesis of POVL remains questionable in most cases, many studies have tried to find out risk factors associated with POVL. Among the many factors that are speculated to increase the risk of POVL, elevated intraocular pressure (IOP) during perioperative periods is one of the most important indicators that may lead to mechanical injury to ganglion cell axon and decreased ocular perfusion pressure (OPP) leading to ischemic optic neuropathy which is the most common type of POVL.[2,3]

Robot-assisted laparoscopic radical prostatectomy (RLRP) has been favorable since it was first introduced in 2001 and it is widely replacing conventional open prostatectomy. RLRP entails benefits of reduced blood loss, nerve sparing, less postoperative pain, and shorter hospital stay.[4] For the optimal surgical exposure, RLRP usually asks for a steep Trendelenburg position and prolonged intraperitoneal carbon dioxide (CO_2) insufflations resulting in elevated IOP.[5] The patients who undergo RLRP are usually old aged with underlying medical problems. As the age of the patient group gets older and as medical diseases such as hypertension and diabetes gets more involved, patients tend to be vulnerable to POVL which results from increased IOP. In addition to this, old aged groups have high risk of having undiagnosed glaucoma thus managing IOP during RLRP is important to anesthesiologists.[6,7]

Many studies have shown that anesthetic agent including intravenous hypnotic agent, inhalation anesthetics, and opioid decrease IOP.[8-13] Also, some studies compared the IOP decreasing effects of various anesthetics and reported that propofol was superior in IOP taming effect than inhalation anesthetics,[10,11] while some others did not.[12-14] In spite of this, there were no studies has been done to a group that is vulnerable to optic nerve neuropathy resulting from increased IOP. Therefore we conducted a prospective randomized study to compare the effect of propofol and sevoflurane on IOP in elderly patients undergoing RLRP requiring prolonged steep Trendelenburg position and pneumoperitoneum which could result in a significant increase of IOP. We expected to see which anesthetics effectively prevented the further increase of IOP in a situation with continuously increased IOP in old aged patient group.

II. MATERIALS AND METHODS

This trial was conducted at Yonsei University Health System in Seoul, Republic of Korea, between November 2010 and May 2011. In addition to an approval of the Institutional Review Board of Yonsei University Health System (4-2011-0034) and registration at http://clinicaltrials.gov (Unique Identifier: NCT01744262), this study was performed in full compliance with the Declaration of Helsinki. All participants were recruited from the anesthesiology preoperative evaluation clinic and were provided a written informed consent. Sixty six male patients scheduled for RLRP with an ASA physical status of I or II, in age over 50 years, were enrolled. We excluded the patients who received eye surgery previously, have elevated baseline IOP of over 30 mmHg, had allergic or adverse reaction to anesthetic drugs, or had unstable angina or congestive heart failure. Patients were randomly allocated to either the balanced anesthesia (Control group) or TIVA (TIVA group) group by means of random numbers generated by a computer. All enrolled patients were evaluated by an ophthalmologist who is not involved in the study to catch any undiagnosed severe intraocular hypertension or other ophthalmologic disorders.

All patients were premedicated with intramuscular midazolam 0.05 mg/kg and glycopyrrolate 0.2 mg at 1 hour and just before the induction of anesthesia, respectively. Standard monitoring devices were applied. In the TIVA group, propofol and remifentanil were concurrently infused using a target controlled infusion (TCI) system (Orchestra® Base Primea, Fresenius Vial, France) for induction and maintenance of anesthesia. Effect site concentration was controlled using the Marsh[14] and Minto models[15] for propofol and remifentanil, respectively. After the loss of consciousness, intravenous rocuronium 0.6 mg/kg was administered for relaxation. Preoperatively, a 20-G radial artery catheter was inserted under local anesthetics for continuous blood pressure monitoring and central venous catheter via right internal jugular for

central venous pressure (CVP) monitoring. Mean arterial pressure was measured with the transducer calibrated at the level of eye to reflect mean ophthalmic artery pressure and CVP at the level of heart. The arterial pressure dome was adjusted in accordance to the change of the position. The effect site concentrations of propofol and remifentanil were kept within the ranges of 2-5 mcg/ml and 2-5 ng/ml, respectively. In the Control group, anesthesia was induced with propofol bolus (1.5 mg/kg) and remifentanil, and maintained with sevoflurane and remifentanil. Like the TIVA group, remifentanil was infused using a TCI system. The end-tidal concentration of sevoflurane and the effect site concentrations of remifentanil were kept within the ranges of 1.5-2.5% and 2-5 ng/ml, respectively. During the surgery, concentrations of propofol, sevoflurane, and remifentanil were titrated to maintain the arterial blood pressure and heart rate within 20% of baseline values. The depth of anesthesia was monitored using a bispectral index score monitor (A-200 bispectral index score monitor, Aspect Medical System Inc., Newton, MA, USA) within the range of 40–60. Controlled ventilation was performed with 40% oxygen in air to maintain end-tidal CO_2 at 35-40 mmHg during the surgery. Body temperature was adjusted to be between 36–37°C using a forced air warming system throughout the surgery. During the operation, CO_2 pneumoperitoneum was induced to maintain an intraabdominal pressure of 15 ± 5 mmHg using the Da Vinci Robot Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) in a 30° Trendelenburg position.

MAP and IOP were measured at nine predefined time points (Table 1). IOP was measured by one ophthalmologist who is blind to the study using a handheld applanation tonometer (Tono-Pen® XL, Medtronic, Jacksonville, FL) at all time points. At each time point, IOP was measured three times and the median values were used as data for the analysis. At T1 to T7, invasive monitoring of MAP was performed by the radial artery catheter and non-invasive NBP was measured at T0 and T8 in a supine horizontal position.

Mean OPP was calculated by the differences between the MAP measured at the eye level and IOP.[6] CVP was measured from T1 to T6, and peak inspiratory pressure (PIP) and end tidal CO_2 ($EtCO_2$) from T1 to T5. Arterial blood gas analysis was carried out at T1, T3, and T5.

Continuous variables were shown as means ± SD and dichotomous variables were shown as numbers (percentages). Between-group comparisons of continuous variables were performed by independent Student *t* test. Dichotomous variables were compared using chi-square or Fisher exact tests as appropriate. Repeated measured variables such as IOP, OPP, MAP, CVP, $ETCO_2$, and PIP were analyzed using a linear mixed model with patient indicator as a random effect, group, time, and group-by-time as fixed effects. Linear mixed models were used to assess correlation between IOP and PIP, CVP, and $ETCO_2$ over the time period T1-T5, and *P* values was calculated using Fisher's z transformation. All statistical tests were two-tailed. *P* values less than 0.05 were considered statistically significant. This study was designed to validate the superiority of propofol anesthetics. In previous study, IOP of the propofol group at post anesthetic induction was 6.0±3.2mmHg compared to 8.9±3.4mmHg of the sevoflurane group[15]. To detect a 2 mmHg difference in IOP (standard deviation of 2.4)[15], power estimation analysis suggested that 33 patients per group would be required to obtain a power of 80%, considering a type I error of 0.05. All statistical analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA).

Table 1. T0-T8 time points

Time point	Event
T0	Before the induction of the anesthesia (awake in supine, horizon position)
T1	5 min after anesthetic induction (mechanical ventilated, before pneumoperitoneum in horizontal position)
T2	5 min after establishing pneumoperitoneum with CO2 in horizontal position
T3	30 min after steep Trendelenburg position with CO2 insufflation
T4	5 min after return to horizontal position with CO2 insufflation
T5	5 min after evacuation of insufflated CO2 in horizontal position
T6	5 min after awakening in the operating room
T7	60 min after awakening in the recovery room
T8	24 hours after the operation

III. RESULTS

RLRP was performed as planned in all patients and complete data sets from the 66 patients were analyzed without any missing data. One patient of the control group and one patient of the TIVA group were advised to consult an ophthalmologist due to normotensive glaucoma at baseline. There were no differences in demographic data, duration of anesthesia, pneumoperitoneum time, Trendelenburg time, and intraoperative input and output between the two groups (Table 2). Intraoperative arterial blood gas data including arterial partial pressure of oxygen (O2) and CO2, pH, and bicarbonate (HCO3-) levels were also similar in both groups (Table 3).

Table 2. Patients demographics and intraoperative variables

Variables	Control (n=33)	TIVA (n=33)	p value
Age (yrs)	65.1 ± 6.7	64.7 ± 8.3	0.811
BMI (kg/m2)	24.1 ± 2.6	24.2 ± 2.2	0.964
ASA class II	19 (57.6)	22 (66.7)	0.447
Diabetes mellitus	4 (12.1)	6 (18.2)	0.492
Hypertension	15 (45.5)	14 (42.4)	0.804
Duration, total (min)	187.1 ± 44.6	183.8 ± 49.4	0.716
Duration, pneumoperitoneum (min)	111.2 ± 38.7	108.1 ± 41.6	0.767
Duration, trendelenburg (min)	97.3 ± 38.9	94.8 ± 45.4	0.722
Fluid intake (ml)	1558.3 ± 556.6	1484.8 ± 587.6	0.554
Urine output (ml)	195.1 ± 98.8	210.6 ± 119.5	0.428
Blood loss (ml)	430.6 ± 269.3	414.5 ± 211.2	0.659

Values are mean ± SD or numbers (%)
BMI = body mass index
ASA = American society of anesthesiologists

Table 3. Intraoperative arterial blood gas analysis

Variables	Time points	Control (n=33)	TIVA (n=33)	p value
pH	T1	7.42 ± 0.03	7.41 ± 0.03	0.083
	T3	7.36 ± 0.06	7.34 ± 0.06	0.18
	T5	7.34 ± 0.04	7.35 ± 0.04	0.561
PaO2	T1	234.1 ± 57.7	216.8 ± 38.8	0.174
	T3	188.1 ± 30	179.3 ± 31.3	0.263
	T5	199 ± 47.5	180.3 ± 34	0.075
PaCO2	T1	33.6 ± 2.7	34.4 ± 3.1	0.235
	T3	42.3 ± 8.2	44.8 ± 9.3	0.245
	T5	43.9 ± 5.4	44.9 ± 5.6	0.499
HCO3-	T1	22.5 ± 1.3	22.6 ± 1.8	0.761
	T3	23.7 ± 1.7	24.2 ± 2.2	0.473
	T5	23.7 ± 1.7	24.3 ± 1.7	0.174

values are mean ± SD

Hemodynamic variables (MAP, HR and CVP) during perioperative period, intraoperative PIP and $EtCO_2$ were similar in both groups (Figure 1). Figure 2A shows the changes of IOP in each group. There were no significant differences in IOP and OPP at baseline (T0) and anesthetic induction reduced IOP in both groups (T1). In the control group, IOP increased significantly at T3, T4, T6, and T7 time points compared to the baseline. However in TIVA group, IOP increased only at T3 compared to the baseline. IOP values at T2 to T4 and T6 time points were significantly lower in TIVA group than the control group. Figure 2-B and C shows IOP changes in each enrolled patients. The number of patients whose IOP had not exceed the upper limit of 20 mmHg preoperatively but exceeded 21mmHg at least once during the period of study were 22 (81.5%) out of 27 in the control group and 14 (56%) out of 25 in TIVA group (P=0.047).

Of these, the number of patients whose IOP increased to higher than 24mmHg were 20 (74.1%) in the control group, 8 (32%) in TIVA group (p=0.002). OPP values of TIVA group were significantly higher at T2 to T4 time points compared to the control group (Figure 3). In both groups, no patient experienced any ophthalmic complication.

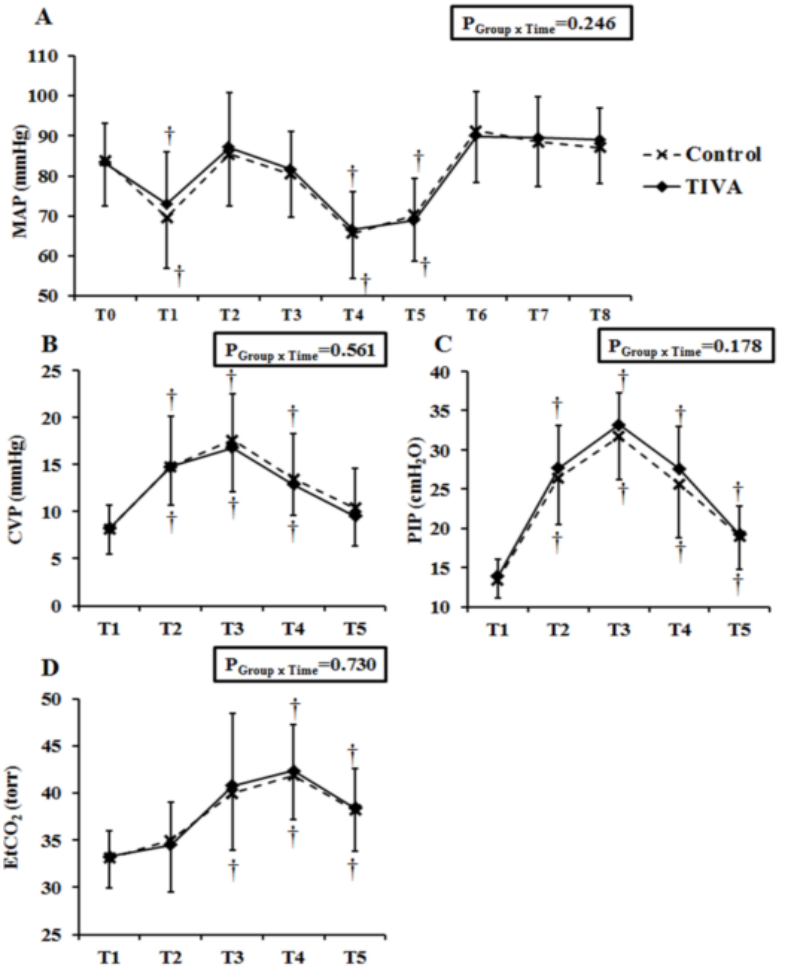

Figure 1. Hemodynamic and intraoperative variables of the two groups
Measurements were made before anesthesia induction (awake in supine, horizontal position, T0), 5 minutes after anesthesia induction (mechanically ventilated, before CO_2 pneumoperitoneum in supine, horizontal position, T1), 5 min after establishing CO_2 pneumoperitoneum in horizontal position (T2), 30 min after CO_2 pneumoperitoneum in the steep Trendelenburg position (T3), 5 min after returning to horizontal position with CO_2 pneumoperitoneum (T4), 5 min after desufflation of CO_2 pneumoperitoneum (T5), 5 min after tracheal extubation in the operating room (T6), 60 min after tracheal extubation in the recovery room (T7), and at 24 hours after the operation (T8). Mean arterial pressure (MAP), heart rate (HR) and central venous pressure (CVP) during the entire perioperative period was not different between the two groups. B: End-tidal CO_2 ($ETCO_2$) levels and peak inspiratory pressures (PIP) during the intraoperative period were not different between the two groups.

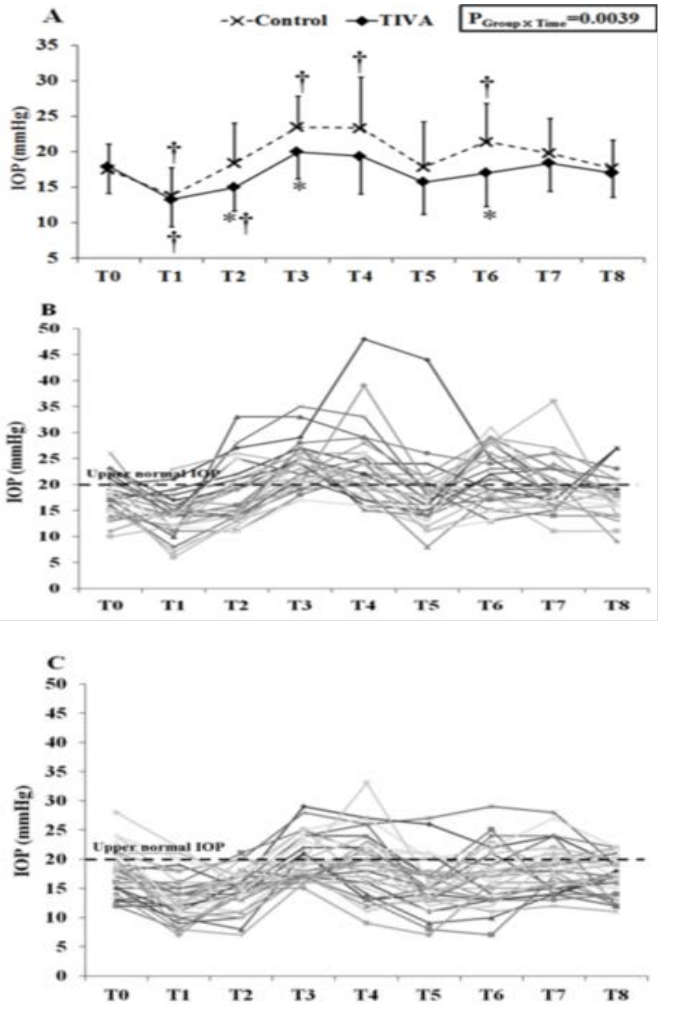

Figure 2. Changes in intraocular pressures (IOP) in the control and TIVA groups at each time point. Measurements were made before anesthesia induction (awake in supine, horizontal position, T0), 5 minutes after anesthesia induction (mechanically ventilated, before CO_2 pneumoperitoneum in supine, horizontal position, T1), 5 min after establishing CO_2 pneumoperitoneum in horizontal position (T2), 30 min after CO_2 pneumoperitoneum in the steep Trendelenburg position (T3), 5 min after returning to horizontal position with CO_2 pneumoperitoneum (T4), 5 min after desufflation of CO_2 pneumoperitoneum (T5), 5 min after tracheal extubation in the operating room (T6), 60 min after tracheal extubation in the recovery room (T7), and at 24

hours after the operation (T8). A: The mean IOPs of each group at each time point. While IOP increased significantly at T3, T4, T6 and T7 compared to baseline in the control group, IOP was increased only at T3 in the TIVA group. IOP was significantly lower in the TIVA group at T2, T3, T4 and T6 compared to the control group. B: IOP of every patient of the control group at each time point. 22 out of 27 (81.5%) patients with normal IOP levels at baseline presented with an IOP of 21mmHg or higher at least once during the study period. C: IOP of every patient of the TIVA group at each time point. 14 out of 25 (56%) patients with normal IOP levels at baseline presented with an IOP of 21 mmHg or higher at least once during the study period.

* $p < 0.05$ compared to the Sevoflurane group , †$p < 0.05$ compared to baseline.

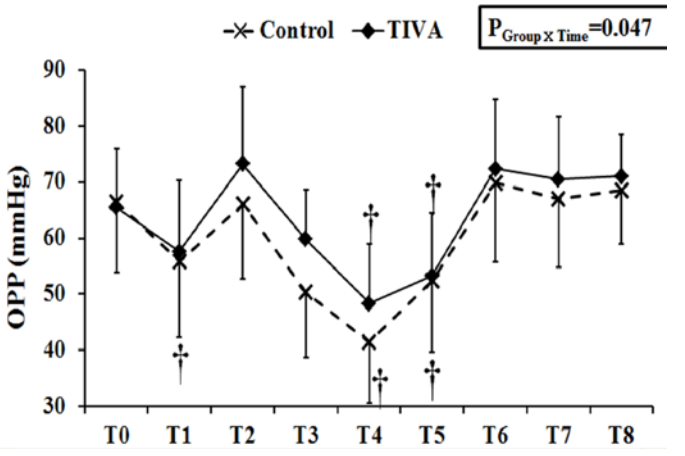

Figure 3. Changes in mean ocular perfusion pressures (OPP) in the control group and TIVA group at each time point. Measurements were made before anesthesia induction (awake in supine, horizontal position, T0), 5 minutes after anesthesia induction (mechanically ventilated, before CO_2 pneumoperitoneum in supine, horizontal position, T1), 5 min after establishing CO_2 pneumoperitoneum in horizontal position (T2), 30 min after CO_2 pneumoperitoneum in the steep Trendelenburg position (T3), 5 min after returning to horizontal position with CO_2 pneumoperitoneum (T4), 5 min after desufflation of CO_2 pneumoperitoneum (T5), 5 min after tracheal extubation in the operating room (T6), 60 min after tracheal extubation in the recovery room (T7), and at 24 hours after the operation (T8). OPPs of the TIVA group were significantly higher at T2 and T4 compared to the control group.

* $p < 0.05$ compared to the Sevoflurane group , †$p < 0.05$ compared to baseline.

IV. DISCUSSION

In this randomized controlled trial addressing the effect of anesthesia using TIVA with propofol on attenuating IOP increase in patients undergoing RLRP, we observed a statistically significant reduction in IOP during pneumoperitoneum and steep Trendelenburg position as well as faster recovery of IOP after surgery in the TIVA group.

After the anesthetic induction, two groups in this study showed significantly lowered IOP and there was no difference between them (Fig. 2A). However, IOP in TIVA group was lowered much more than that in the control group during the surgery after inducing pneumoperitoneum. In a recent study,[5] IOP of the patients undergoing RLRP with desflurane anesthesia reached the peak level during pneumoperitoneum and steep Trendelenburg position at about 13 mmHg higher than the baseline on average. The point where IOP increased the most in this study were when pneumoperitoneum was induced and steep Trendelenburg position was taken. The IOP increases compared to the baseline at these two points were 9.4mmHg in the control group but only 3.7mmHg in TIVA group. Our results coincided with the past studies whose results proved propofol to be superior in IOP taming effect than any other inhalation anesthetics.[10,11]

Ocular hypertension is defined as an intraocular pressure higher than 21mmHg[16] and the decrease in the number of patients with ocular hypertension in this study was statistically significant in TIVA group. In addition to this, the number of patients whose IOP increased higher than 24mmHg to meet the diagnosing criteria for glaucoma was significantly less in TIVA group. Study of Chan KC et al.[18] on patients with or without glaucoma who undergo LASIK, had reported that a temporary increase of IOP is not associated with the change of a visual function. However, they emphasized that there is a possibility that temporary increase of IOP might have an effect on the visual field defect since

their study had a limitation from its small sized study with only 100 patients. Thus anesthesiologist should always be alert to this. On the contrary, Poostchi A, et al[19] performed a study aimed at same group of patients and reported that IOP elevation even for a short period of time (less than 30 seconds) significantly increased optic disc area and linear disc dimensions. Optic disc size measurement is an important component[20] in the optic nerve head examination of glaucoma patients and concentrated stress at optic nerve head is an important mechanism that causes an optic neuropathy from IOP increase. [6] Therefore these factors are to be carefully considered in patients who are vulnerable to optic neuropathy. There has been no study on the relationship between a transient IOP elevation and an ocular perfusion pressure, a blood supply of the optic nerve head or ganglion axon direct injury. However, induced IOP increase in the case of RLRP lasts longer than other studies mentioned above; thus there is a need for more consideration from the anesthesiologist in old patients undergoing RLRP. The patients who undergo RLRP are also usually old aged and the risk of their having undiagnosed glaucoma increases, so their vulnerability to optic nerve injury increases as well. About 4-10% of the patients over 40 years old have ocular hypertension.[21] It has been known that patients with an ocular hypertension have prevalence rate of primary open angle glaucoma about 10 to 15 times than that of the patients without the disease.[22] Actually in our study, 14 patients out of 66 enrolled patients had ocular hypertension in their pre-anesthetic evaluation and 2 patients were suspected to have normotensive glaucoma.

The decrease of an ocular perfusion pressure along with a mechanical compression on axon is the important mechanism that could induce an optic neuropathy when IOP increases.[1,6,7] In our study, the ocular perfusion pressure during the surgery was maintained significantly higher in TIVA group compared to the control group. This can be clinically important that propofol prevents the

increase of IOP. Thus it decreases the incidence rate of optic neuropathy by lowering the chance of ocular hypoperfusion.

On the other side, decreased IOP after the CO_2 evacuation began to increase again at acute postoperative period. Vasoconstriction and venoconstriction from the adrenergic stimulation increase the resistance toward the outflow of trabecular meshwork between the anterior chamber and Schlemm's canal and this is known to cause IOP increase.[23] From this, we could conclude that IOP increase at the acute postoperative period is related to the increase of a sympathetic tone due to the postoperative pain and the anxiety. In the control group, increased IOP was maintained higher than the baseline until 1 hour postoperatively. Despite this difference, the range of IOP increase in TIVA group was not large as that of the control group and there was no difference in MAP, CVP, and HR throughout the perioperative period.

Previous studies have reported that the increase of sympathetic nervous system activity, $ETCO_2$, patient position, and the surgical duration at IOP increasing position are the factors that affect IOP increase.[1,2,5,7,23] Even though MAP, HR, CVP, $ETCO_2$, and PIP during the surgery showed no difference between two groups in this study, there was a clear correlation between IOP and changes in CVP and PIP intraoperatively. Overall, we could not identify any of these factors as the cause of lower IOP in TIVA group. Overall, although the results of our study partially support those of previous reports, we were not able to identify any of the aforementioned factors as the cause of lower IOP observed in the TIVA group. There was no intergroup difference in CVP, PIP or even $ETCO_2$, which implies that other underlying pathways may exist in the mechanism by which propofol attenuates the increase in IOP.

Arginine and vasopressin induced by pneumoperitoneum and Trendelenburg position are also known to be another possible cause for the IOP increase.[24,25] Mowafi et al had reported that propofol inhibits the secretion of arginine vasopressin from the supraoptic nucleus[26] and prevents IOP increase.

On the contrary, inhalation agents do not inhibit the blood concentration of vasopressin[27] thus propofol can successfully prevent the IOP increase. Recently Shimogai et al had reported that isoflurane and sevoflurane effectively inhibits the increase of the blood concentration of arginine vasopressin.[28] In order to prove this, there is a need of a study to investigate the possible effect of propofol and inhalation anesthetics on the secretion of AVP in surgeries that involves pneumoperitoneum and steep Trendelenburg position.

Limitation of this study is that the sympathetic nervous system activation was expected to be the indirect parameter like MAP, HR or CVP. Applying other monitoring devices such as heart rate variability analysis or direct measurements of blood catecholamine levels would have shed more light on the results of this study. Secondly, OPP was calculated by measuring MAP and IOP, rather than directly measuring the blood flow at the optic nerve head. Lastly, the duration of surgery observed in this study was relatively short. Longer operation times have been demonstrated to be correlated with ION in spine surgeries in the prone position[2] as well as in surgeries done in the steep Trendelenburg position. The mean duration of pneumoperitoneum in the Trendelenburg position was approximately 90 minutes in this study, and thus the clinical effect of propofol based TIVA to reduce IOP in patients undergoing surgeries of a prolonged duration is not clear. Further studies that are conducted in longer robotic procedures are needed to explore this aspect.

V. CONCLUSION

In conclusion, we could confirm that the anesthesia using TIVA with propofol significantly prevented the IOP increase induced by pneumoperitoneum and steep Trendelenburg position when it is compared to the balanced anesthesia with sevoflurane. Also, using TIVA with propofol was associated with faster normalization of elevated IOP at the postoperative period. We believe our study has a clinical significance in that the study was aimed at patients who were vulnerable to the ocular complications. Thus, maintaining low IOP under the anesthesia using TIVA with propofol may be beneficial especially in patients who are vulnerable to ocular complication due to IOP increase.

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ABSTRACT (IN KOREAN)

다빈치 로봇을 이용한 복강경적 근치적 전립선 절제술을 시행 받는 환자에서 수술 중 Intraocular Pressure의 변화에 대한 완전정맥마취와 흡입마취의 비교

<지도교수 배선준 >

연세대학교 대학원 의학과

최은경

경사가 심한 트렌델렌버그 자세와 오랜 기복상태를 유지하는 로봇을 이용한 복강경내 전립선 절제술을 시행 받는 환자에서의 안 내압은 의미 있게 증가한다. 전립선절제술을 시행 받는 환자군은 대부분 동반된 만성질환을 가지는 고령이며 이들은 수술 후 시력저하 가능성이 높은 군이다. 우리가 자주 사용하는 마취제는 안 내압을 저하시키는 것으로 알려져 왔다. 우리가 시행한 본 연구에서는 프로포폴을 사용한 전 정맥마취와 마취가스를 사용한 마취 시 각 마취제가 로봇을 이용한 전립선 절제술을 받는 환자들의 안 내압에 미치는 영향을 비교

분석하여 보았다. 총 66명의 환자들은 가스를 사용하는 컨트롤그룹과 프로포폴을 사용하는 TIVA 그룹으로 나뉘어져 연구되었다. 9개의 다른 시점을 지정하고 각 시점에서의 안내압이 측정되었다. 그 결과 우리는 프로포폴을 사용한 TIVA그룹에서 기복과 경사가 심한 트렌델렌버그 자세에서 결과하는 안 내압 증가가 효과적으로 예방되는 것을 관찰할 수 있었다. 이는 안과적 합병증의 위험도가 높은 환자들이 복강경내 전전립선 절제술을 받을 시 프로포폴을 사용한 전 정맥마취가 도움이 될 수 있음을 의미할 수 있겠다.

핵심이 되는 말: 안내압, 로봇을 이용한 전전립선절제술, 프로포폴, 정맥마취