Cardiovascular Effects of Volatile Induction and Maintenance of Anesthesia (VIMA) and Total Intravenous Anesthesia (TIVA) for Laryngeal Mask Airway (LMA) Anesthesia: A Comparison Study

Wariya Sukhupragarn MD*,
Prangmalee Leurcharusmee MD*, Thitipan Sotthisopha MD*

** Department of Anesthesiology, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand*

Objective: *To compare changes of heart rate and blood pressure in patients that underwent LMA anesthesia with VIMA or TIVA technique.*

Material and Method: *A hundred healthy patients, age 16 to 60 years were enrolled. They were randomized into two groups. Patients in group V (VIMA) were induced with 8% sevoflurane until loss of eyelash reflexes then controlled ventilation for five minutes before LMA insertion. Group T (TIVA) patients were given propofol to reach the affected site concentration of eight mcg/ml for the LMA insertion. Blood pressure and heart rate were recorded before induction, immediately before and after LMA insertion then every two minutes until surgical incision.*

Results: *Decreased SBP from baseline in group T was significantly more than group V in each period of time (D1-D7). DBP in group T decreased more than group V significantly only at eight and ten minutes after LMA insertion. The incidence of decreasing SBP >20% from baseline was more significant in group T than group V. No significant difference of changed HR was found. Coughing during LMA insertion occurred in eight patients (16%) in group T and in three patients (6%) in group V ($p = 0.11$).*

Conclusion: *Induction with propofol by effective site concentration of eight mcg/ml significantly decreased SBP more than with 8% sevoflurane. Both techniques provided smooth LMA insertion without serious complication.*

Keywords: *TIVA, VIMA, LMA, Total intravenous anesthesia, Volatile induction and maintenance of anesthesia, Laryngeal mask airway*

J Med Assoc Thai 2015; 98 (4): 388-93
Full text. e-Journal: *http://www.jmatonline.com*

General anesthesia consists of three phases, induction, maintenance and emergence. The most popular technique is to use intravenous anesthetics for induction and volatile anesthetics for maintenance of anesthesia; this technique requires volatile anesthetics to reach an adequate level before intravenous anesthetics become ineffective. Single agent techniques that have been described are VIMA (Volatile Induction and Maintenance of Anesthesia) with sevoflurane and TIVA (Total Intravenous Anesthesia) with propofol. These two techniques use a single agent to keep depth of anesthesia with no transition between the induction and maintenance phase[1].

Laryngeal mask airway (LMA) is airway equipment that does not pass through the vocal cords during ventilation. LMAs are usually used during surgeries in which muscle relaxation is not needed and spontaneous ventilation is desired. TIVA and VIMA techniques can be used for LMA anesthesia but need a higher dose for laryngeal mask airway insertion without muscle relaxant. Both sevoflurane and propofol cause dose-dependent reduction in myocardial contractility. Previous studies compared cardiovascular responses of VIMA and TIVA shown different results including propofol decreased blood pressure more than sevoflurane[2,3], changing of blood pressure were comparable in two group[4,5]. The induction techniques were different among these studies. The aim of the present study was to compare cardiovascular effects of VIMA and TIVA for LMA anesthesia with the induction technique that has been used in our institution.

Correspondence to:
Sukhupragarn W, Department of Anesthesiology, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand.
Phone: +66-53-945522, Fax: +66-53-945526
E-mail: wariya.s@cmu.ac.th

Material and Method

After approval by the Ethics Committee of the Faculty of Medicine, Chiang Mai University,

100 healthy patients aged between 18 to 60 years scheduled for LMA anesthesia were enrolled in the present study. Patients who were contraindicated for the use of LMA, propofol or sevoflurane, and patients with cardiovascular diseases were excluded from the study. After obtaining written informed consent, patients were allocated randomly to one of two groups, group T (TIVA), or group V (VIMA), using computer generated random numbers and sequentially numbered sealed envelopes. After arrival in the operating room, all patients received routine monitoring and preoxygenation with 100% oxygen flow at the rate of six liters per minute. In group T, anesthesia was induced with propofol using target control infusion (TCI). Target induction concentration was eight mcg/ml then decreased to two to six mcg/ml after LMA insertion (lower dose in case of significant hypotension, higher dose in case of patient movement, and three mcg/ml in uneventful cases). In group V, 8% sevoflurane in 100% oxygen flow rate six liters per minute was used for induction until the patient loss of eyelash reflexes then sevoflurane was decreased to 5% and ventilation was controlled for five minutes before LMA insertion. The concentration of sevoflurane was decreased to one to three percent after LMA insertion depending on the patient respond to stimuli (lower dose in case of significant hypotension, higher dose in case of patient movement, and two percent in uneventful cases). Blood pressure and heart rates before induction, immediately before LMA insertion, immediately after LMA insertion, and then every two minutes until the surgical incision were recorded. All adverse effects during induction and LMA insertion such as involuntary movements, coughing, breathe holding, laryngospasm and desaturation were noted. LMA insertion using Dr. Brain technique, adequate chest movement, and absence of audible leak at the airway pressure of 20 cmH_2O was to confirm the proper position of the LMA. One mcg/kg of fentanyl was given before the surgical incision was initiated.

Results

One hundred patients were enrolled in the present study. There were no differences in patient demographic data between groups as shown in Table 1. Even though all patients in the present study had no cardiovascular disease, baseline systolic blood pressure (SBP), mean arterial pressure (MAP), diastolic

Table 1. Patient demographic data (Group T = TIVA, Group V = VIMA)

	Group T		Group V		*p*-value
	n (%)	Mean	n (%)	Mean	
Sex					
Male	18 (36)		18 (36)		1.000
Female	32 (64)		32 (64)		
Age		42.44		41.96	
18-40	20 (40)		21 (42)		0.840
41-60	30 (60)		29 (58)		
Weight (kg)		56.18		58.46	0.272
Height (m)		1.58		1.59	0.464
BMI (kg/m^2)		22.57		23.05	
<20	11 (22)		12 (24)		0.467
20-25	26 (52)		21 (42)		
>25	13 (26)		17 (34)		
ASA status					
I	45 (90)		45 (90)		1.000
II	5 (10)		5 (10)		
Airway assessment					
Interincisor gap (cm)		3.48		3.44	0.703
Mallampati I	33 (66)		26 (52)		0.274
Mallampati II	15 (30)		19 (38)		
Thyromental distance		6.08		6.14	0.769

ASA = American Society of Anesthesiologists; TIVA = total intravenous anesthesia; VIMA = volatile induction and maintenance of anesthesia; BMI = body mass index

blood pressure (DBP) and heart rate (HR), were statistically different between the two groups, revealed in Table 2. The authors decided to compare the change of each parameter from the baseline at specific times. D1 = the value that was measured before LMA insertion - Baseline, D2 = the value after the 1st attempt of LMA insertion - Baseline, D3 = the value at two minutes after the 1st attempt of LMA insertion - Baseline, D4 = the value at four minutes after the 1st attempt of LMA insertion - Baseline, D5 = the value at six minutes after the 1st attempt of LMA insertion - Baseline, D6 = the value at eight minutes after the 1st attempt of LMA insertion - Baseline, and D7 = the value at ten minutes after the 1st attempt of LMA insertion - Baseline. The data were shown in Table 3. Normal distribution data was compared using student-t test, Mann-Whitney U test was used for the rest. All parameters tended to decrease from baseline

Table 2. Baseline cardiovascular parameters were significantly different by statistics

Baseline	Group T (n = 50)		Group V (n = 50)		t-test
	Mean	SD	Mean	SD	*p*-value
SBP	124.88	11.35	117.30	11.56	0.0013
MAP	92.64	8.63	87.28	10.63	0.0067
DBP	74.90	9.18	70.40	9.46	0.0177
HR	78.44	13.03	70.74	11.02	0.0019

SBP = systolic blood pressure; MAP = mean arterial pressure; DBP = diastolic blood pressure; HR = heart rate

Table 3. Comparison of the changed cardiovascular parameters from baseline over time

Changed from baseline	Parameters	Group T		Group V		*p*-value
		Mean	SD	Mean	SD	
D1	SBP	-15.32	15.10	-7.84	10.40	0.020
	MAP	-9.70	11.92	-8.18	10.57	0.651
	DBP	-6.88	10.97	-5.88	8.53	0.364
	HR	-2.00	8.33	-0.14	5.46	0.190
D2	SBP	-10.56	14.48	-10.44	10.35	0.962
	MAP	-8.92	12.89	-7.94	10.92	0.920
	DBP	-6.48	12.71	-7.68	10.20	0.679
	HR	-0.86	10.60	-2.88	6.06	0.245
D3	SBP	-17.20	15.12	-9.26	8.00	0.001
	MAP	-10.46	13.40	-7.38	10.25	0.200
	DBP	-9.42	11.90	-7.10	8.21	0.259
	HR	-0.82	10.83	-3.00	9.10	0.600
D4	SBP	-20.46	15.80	-13.12	12.11	0.011
	MAP	-15.94	13.28	-11.56	11.11	0.077
	DBP	-12.66	12.06	-9.52	10.42	0.167
	HR	-3.74	10.08	-4.92	8.98	0.538
D5	SBP	-24.78	16.35	-13.56	15.24	0.004
	MAP	-15.64	13.30	-11.36	13.43	0.113
	DBP	-15.04	11.44	-11.24	11.78	0.105
	HR	-5.36	9.74	-5.56	9.86	0.919
D6	SBP	-25.50	16.76	-13.68	14.02	0.002
	MAP	-16.66	13.23	-11.66	12.10	0.051
	DBP	-14.86	12.00	-9.54	10.50	0.020
	HR	-5.26	9.99	-4.20	10.07	0.863
D7	SBP	-22.94	17.97	-10.26	12.84	<0.001
	MAP	-13.66	13.41	-7.68	12.47	0.023
	DBP	-12.60	12.16	-7.56	11.34	0.035
	HR	-5.16	9.72	-3.40	9.39	0.359

LMA = laryngeal mask airway

D1 = the value that were measured before LMA insertion - Baseline, D2 = the value after the 1st attempt of LMA insertion - Baseline, D3 = the value at 2 minutes after the 1st attempt of LMA insertion - Baseline, D4 = the value at 4 minutes after the 1st attempt of LMA insertion - Baseline, D5 = the value at 6 minutes after the 1st attempt of LMA insertion - Baseline, D6 = the value at 8 minutes after the 1st attempt of LMA insertion - Baseline, and D7 = the value at 10 minutes after the 1st attempt of LMA insertion - Baseline

more in group T. Decreased SBP from baseline in group T was significantly more than group V in all periods of time (D1-D7). MAP and DBP in group T were decreased more than group V significantly only in D7 and D6-D7 respectively. No significant difference of changed HR was found. The incidence of decreasing SBP >20% from baseline was more significant in group T than group V except immediately after LMA insertion as described in Table 4. Coughing during LMA insertion occurred in eight patients (16%) in group T and in three patients (6%) in group V (p = 0.11). Ninety-eight percent of group V, LMA insertion was successful in the first attempt. In group T 82% of insertion was done the first time and 16% required another attempt.

Table 4. Incidence of decreased systolic blood pressure below 20 percent from baseline

Decreased SBP >20% from baseline	Group T		Group V		X^2 test
	n	%	n	%	p-value
Before LMA insertion	10	20	1	2	0.004
After LMA insertion					
0 minute	9	18	7	14	0.585
2 minutes	16	32	2	4	<0.001
4 minutes	21	42	11	22	0.032
6 minutes	26	52	10	20	0.001
8 minutes	25	50	10	20	0.002
10 minutes	21	42	3	6	<0.001

Discussion

Several studies described techniques for inhalation induction with sevoflurane such as slowly increasing concentration by 1 to 2%[6], vital capacity breathing with 8% sevoflurane[7] that took 45 to 90 seconds to lose eyelash reflex and 120 to 180 seconds to be ready for LMA insertion. The authors experienced patient movement or hypotension from the vital capacity technique. Bispectral index was used to find optimal time and concentration to reach bispectral index of 40 in 10 patients before the present study. The result was to use 8% sevoflurane until the patient loss of eyelash reflex then decreased concentration to 5% and control ventilation for five minutes; this also achieved at least 4% end tidal sevoflurane, which was adequate for LMA insertion. The dosage of propofol induction for LMA insertion has been described as 2 to 2.5 mg/kg[8], 3 mg/kg[3], or target concentration can be vary from 5 to 8 mcg/ml[9]. The target concentration of 8 mcg/kg was chosen because it was claimed as the fastest and higher success rate of LMA insertion without major hemodynamic effect[9].

Kanaya et al[10] found no significant changes in heart rate from either propofol or sevoflurane induction, the same as our study. Hall et al[11] revealed different results in cardiovascular response between single-breath inhalation induction of sevoflurane and intravenous bolus of propofol. This might be caused by different induction technique from our study. The incidence of decreased systolic blood pressure more than 20% from baseline were significantly higher in group T but not lower than 90 mmHg and self-limited.

Ti et al[3] compared the quality and ease of LMA insertion between vital capacity breath with 8% sevoflurane and propofol three mg/kg. They found four insertion failures in the propofol group due to an inability to open the patient's mouth and need for succinylcholine to rescue, while all insertions in the sevoflurane group were successful. The overall incidence of complications in propofol group was significantly higher than sevoflurane in their study. In this study, some coughing occurred during LMA insertion [16% in group T, 6% in group V] but no other serious complications such as breath holding, laryngospasm or desaturation occurred. Patient movement was found in group T (30%) and none in group V. Nevertheless, the induction time in group V of this study needed a few minutes longer than VIMA technique in previous study[6] and five more minutes compare to group T that might be one of the point to make decision for each of the patients.

Conclusion

Induction with propofol by effective site concentration of eight mcg/ml significantly decreased the SBP more than eight percent of sevoflurane. Both techniques provided smooth LMA insertion without serious complications.

What is already known on this topic?

TIVA and VIMA can be used for LMA anesthesia. Dosage of propofol and the technique of inhalation induction are varying among literatures. Previous literatures do not describe step of inhalation induction clearly. Higher dose provides smooth LMA insertion but causes more hypotension.

What this study adds?

Inhalation induction with 8% sevoflurane until the patient loss of eyelash reflex then decrease concentration to 5% and control ventilation for

five minutes provide good LMA insertion condition and cause less hypotension than induction with propofol by effective site concentration of eight mcg/ml.

References

1. Thwaites A, White I. Practical improvements in inhalational anaesthesia. Therapy Express 1998; 117: 1-6.
2. Thwaites A, Edmends S, Smith I. Inhalation induction with sevoflurane: a double-blind comparison with propofol. Br J Anaesth 1997; 78: 356-61.
3. Ti LK, Chow MY, Lee TL. Comparison of sevoflurane with propofol for laryngeal mask airway insertion in adults. Anesth Analg 1999; 88: 908-12.
4. Ogawa Y, Iwasaki K, Shibata S, Kato J, Ogawa S, Oi Y. Different effects on circulatory control during volatile induction and maintenance of anesthesia and total intravenous anesthesia: autonomic nervous activity and arterial cardiac baroreflex function evaluated by blood pressure and heart rate variability analysis. J Clin Anesth 2006; 18: 87-95.
5. Kati I, Demirel CB, Huseyinoglu UA, Silay E, Yagmur C, Coskuner I. Comparison of propofol and sevoflurane for laryngeal mask airway insertion. Tohoku J Exp Med 2003; 200: 111-8.
6. Martin-Larrauri R, Gilsanz F, Rodrigo J, Vila P, Ledesma M, Casimiro C. Conventional stepwise vs. vital capacity rapid inhalation induction at two concentrations of sevoflurane. Eur J Anaesthesiol 2004; 21: 265-71.
7. Yurino M, Kimura H. Efficient inspired concentration of sevoflurane for vital capacity rapid inhalation induction (VCRII) technique. J Clin Anesth 1995; 7: 228-31.
8. Hickey S, Cameron AE, Asbury AJ. Cardiovascular response to insertion of Brain's laryngeal mask. Anaesthesia 1990; 45: 629-33.
9. Taylor IN, Kenny GN. Requirements for target-controlled infusion of propofol to insert the laryngeal mask airway. Anaesthesia 1998; 53: 222-6.
10. Kanaya N, Hirata N, Kurosawa S, Nakayama M, Namiki A. Differential effects of propofol and sevoflurane on heart rate variability. Anesthesiology 2003; 98: 34-40.
11. Hall JE, Stewart JI, Harmer M. Single-breath inhalation induction of sevoflurane anaesthesia with and without nitrous oxide: a feasibility study in adults and comparison with an intravenous bolus of propofol. Anaesthesia 1997; 52: 410-5.

การศึกษาเปรียบเทียบผลกระทบต่อระบบไหลเวียนเลือดจากการใช้ยาดมสลบกับยาสลบทางหลอดเลือดดำ ในการระงับความรู้สึกโดยใช้หน้ากากครอบกล่องเสียง

วริยา สุขุประการ, ปรางค์มาลี ลือชารัศมี, ฐิติพันธุ์ โสตถิโสภา

วัตถุประสงค์: *เพื่อเปรียบเทียบการเปลี่ยนแปลงอัตราการเต้นของหัวใจ และแรงดันเลือด ในผู้ป่วยที่ได้รับยาระงับความรู้สึกโดยใช้หน้ากากครอบกล่องเสียง ด้วยเทคนิคการใช้ยาดมสลบหรือยาสลบทางหลอดเลือดดำเพียงอย่างเดียว*

วัสดุและวิธีการ: *ทำการศึกษาในผู้ป่วย 100 ราย อายุตั้งแต่ 16-60 ปี โดยสุ่มแบ่งเป็น 2 กลุ่ม โดยกลุ่ม V นำสลบด้วยยาดมสลบซีโวฟูเรน เข้มข้นร้อยละ 8 จนผู้ป่วยหลับ แล้วช่วยหายใจต่อด้วยความเข้มข้นร้อยละ 5 นาน 5 นาที จึงใส่หน้ากากครอบกล่องเสียง กลุ่ม T นำสลบด้วยยาโพรโพฟอล โดยตั้งค่าความเข้มข้นของยาที่สมอง 8 ไมโครกรัมต่อมิลลิลิตร จึงใส่หน้ากากครอบกล่องเสียง บันทึกค่าแรงดันเลือดและอัตราการเต้นของหัวใจ ก่อนให้ยา ก่อนและหลังการใส่หน้ากากครอบกล่องเสียง และทุก 2 นาที หลังจากใส่หน้ากากครอบกล่องเสียงจนเริ่มผ่าตัด*

ผลการศึกษา: *เปรียบเทียบค่าการเปลี่ยนแปลงของแรงดันเลือดและอัตราการเต้นของหัวใจจากค่าพื้นฐานของผู้ป่วยแต่ละราย พบว่าค่าแรงดันเลือดตัวบนในกลุ่ม T ลดลงมากกว่ากลุ่ม V อย่างมีนัยสำคัญทางสถิติในเกือบทุกช่วงเวลา ค่าแรงดันเลือดตัวล่างในกลุ่ม T ลงลดมากกว่ากลุ่ม V ในนาทีที่ 8 และ 10 หลังใส่หน้ากากครอบกล่องเสียง อุบัติการณ์ค่าแรงดันเลือดตัวบนตกมากกว่าร้อยละ 20 ของค่าพื้นฐานในกลุ่ม T มีมากกว่ากลุ่ม V อย่างมีนัยสำคัญ ไม่พบความแตกต่างในการเปลี่ยนแปลงอัตราการเต้นของหัวใจระหว่างกลุ่ม พบการไอระหว่างใส่หน้ากากครอบกล่องเสียง 8 ราย (ร้อยละ 16) ในกลุ่ม T และ 3 ราย (ร้อยละ 6) ในกลุ่ม V ($p = 0.11$)*

สรุป: *การนำสลบด้วยยาโพรโพฟอลโดยตั้งค่าความเข้มข้นของยาที่สมอง 8 ไมโครกรัมต่อมิลลิลิตร ทำให้ค่าแรงดันเลือดตัวบนต่ำลงมากกว่าวิธีการนำสลบด้วยซีโวฟูเรน เข้มข้นร้อยละ 8 อย่างมีนัยสำคัญ ทั้งสองเทคนิคสามารถใส่หน้ากากครอบกล่องเสียงได้อย่างราบรื่น และไม่พบภาวะแทรกซ้อนที่รุนแรง*