

## ORIGINAL ARTICLE

## Comparison of Inhalational Vital Capacity Induction with Sevoflurane to Intravenous Induction with Propofol

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**Received:** October 10, 2019

**Accepted:** December 20, 2019

**Published:** February 15, 2020

### How to cite this article:

Adhikari KM, Lakhe G et al. Comparison of Inhalational Vital Capacity Induction with Sevoflurane to Intravenous Induction with Propofol. *Nepal Journal of Medical Sciences* 2020;5(1):10-19

### ABSTRACT

**Introduction:** Intravenous propofol is commonly used for induction of general anesthesia because it is smooth and rapid. Inhalational induction method is used in limited situations like absence of venous access and difficult intubation. Sevoflurane also produces rapid induction comparable to propofol. We conducted this study to compare induction time and quality of sevoflurane with that of propofol.

**Methods:** Total 102 patient undergoing elective laparoscopic surgery were divided into Group S and Group P with 51 patient in each group. In group S patient were induced with Sevoflurane 8% via vital capacity induction method. In group P, patients were induced with injection propofol 1% with titrating dose. Induction time, hemodynamic changes and complications during induction, patient satisfaction and cost of induction were compared.

**Results:** Induction was rapid in Group S ( $53.33 \pm 17.29$ s) compared to Group P ( $72.27 \pm 25.15$ s) ( $p=0.01$ ). The heart rate and mean arterial pressure were stable in both groups upto one minute after induction. Hypotension occurred more in Group P than in Group S (47.05% vs. 37.25%). Cough (9.80% vs. 5.88%) and excessive secretions (5.88% vs. 0%) were common in Group S while apnea (3.92% vs. 5.88%) and involuntary movements (17.64% vs. 27.45%) were common in Group P. Patient satisfaction score was high in both the groups. Cost of induction was cheaper in Group S compared with Group P ( $1.6 \pm 0.54$  \$ vs.  $1.9 \pm 0.43$  \$).

**Conclusions:** Vital capacity induction with 8% sevoflurane has rapid induction and cheaper as compared to intravenous induction with propofol in a titrating dose. Hemodynamic changes and complications were comparable in both the groups.

**Key words:** Complications; induction; propofol; sevoflurane.

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## INTRODUCTION

Propofol is most commonly used intravenous anaesthetic agent for induction of general anaesthesia. It is popular because of its rapid and smooth induction. Inhalational induction is common in paediatric population. Its use in adults is limited to situations like absence of venous access and in cases of difficult airway. However, after the introduction of sevoflurane, use of inhalational induction has become popular in adults. It has smooth induction and results in complete recovery. Additionally, speed of induction and qualities are similar to that of propofol when used in high concentration with vital capacity induction (VCI) method. [1, 2]

We conducted this study to evaluate whether VCI with sevoflurane can be used as an alternative technique to intravenous induction of anaesthesia with propofol.

We aimed to compare the quality of induction using sevoflurane and propofol, in terms of speed, hemodynamic changes, complications, patient satisfaction and cost difference.

## METHODS

This cross sectional, analytical study was conducted in the Department of Anaesthesia of Manipal Teaching Hospital, Pokhara from December 12, 2017 to July 22, 2018 after approval from Institutional Review Committee with reference number: MEMG/IRC/GA/115. Written and informed consent was taken from all participants. A total of 102 patients, ASA physical status I and II, aged 16 to 65 years, undergoing elective laparoscopic surgery under general anaesthesia with endotracheal intubation were included. Patients with allergy to study drugs and refusal to participate in the study were excluded.

Sample size calculations was done based on study by Siddhik- Saiyad et al.[3] The induction time in sevoflurane and propofol group in their study was  $45 \pm 12$  and  $39 \pm 9$  seconds respectively.

The sample size was calculated at  $\alpha$  of 5% and power of 80% by using the following formula.

$$n = \frac{2[(a + b)^2 \vartheta^2]}{(\mu_1 - \mu_2)^2}$$

where, n = sample size in each of the groups,  $\mu_1$  = population mean in sevoflurane group,  $\mu_2$  = population mean in propofol group,  $\vartheta$  = population variance (SD), a = conventional multiplier for alpha = 0.05, b = conventional multiplier for power = 0.80. Value of a = 1.96, b = 0.842. The minimum required sample size was 48.08 in each group. However, we have included 51 patients in each group.

Patients were allocated alternately to sevoflurane group (Group S, n=51) and propofol group (Group P, n=51) in the ratio of 1:1.

The sedative premedication was not given. After shifting the patients to operation theatre (OT), venous access was secured on the dorsum of hand with 18G intravenous catheter in all the patients.

In Group S, patients were educated about vital capacity induction (VCI) technique in the pre-operative holding area. They were asked to exhale fully and then take deep breath and hold it as long as they can. They were requested to demonstrate the technique to the investigator to evaluate the appropriateness of the method. The patients were then shifted to OT. Pre-oxygenation was done with 100% oxygen at the rate of six litres/min for three minutes via a separate Bain circuit and oxygen cylinder. The breathing circuit of the circle system was primed with eight percentage sevoflurane and six litre oxygen until the gas analyzer showed expired concentration of sevoflurane more than six percentages. After pre-oxygenation, Bain circuit was removed and primed circuit of circle system with appropriate sized face mask was applied and patients were asked to take vital capacity breath. If the patients were not induced with the single vital capacity breath then induction was continued with the tidal volume breath. Duration of induction was defined as time starting from initiation of vital capacity breath to loss of eye lash reflex. It was recorded using stop watch by anaesthesia resident.

In Group P, after pre-oxygenation with 100% oxygen at the rate of six litres /min for three minutes, patients were induced with propofol (10mg/ml) in titrating dose in a running drip. Duration of induction was defined as time starting from injection of propofol to loss of eye lash reflex. It was recorded using stop watch by anaesthesia resident. The amount of propofol required in millilitres for induction was noted.

The complications during induction of anesthesia like apnoea, cough, involuntary movements, de-saturation, excessive secretion, hiccup, arrhythmias and pain on propofol injection were noted.

Hemodynamic parameters like heart rate (HR), arterial oxygen saturation (SPO<sub>2</sub>), mean arterial pressure (MAP) were noted at baseline and one minute after induction. Change in hemodynamic parameters 15% on either side from baseline were considered significant and considered as having hypertension, hypotension, tachycardia and bradycardia accordingly. Fall in spo<sub>2</sub> below 92% was considered as de-saturation. The cost of induction with sevoflurane and propofol was calculated and compared between two groups.

In Group S, cost was calculated as: millilitre of sevoflurane required for priming the circuit and induction X cost per millilitre. The amount of liquid sevoflurane consumed was calculated using Peter biro's formula.[4]

Amount of liquid volatile agent:

Mean FGF (ml/min) × mean agent concentration (Vol %) × Anesthesia duration (min)

Saturated Gas Volume (ml) × 100 (Vol %)

Where, FGF= Fresh Gas Flow, Saturated Gas Volume for Sevoflurane = 184 ml

In Group P, cost was calculated as: induction dose of propofol in milliliter × cost per milliliter.

The cost of anaesthesia was converted to US Dollar from Nepali currency with the foreign exchange rate at the end of study period.

Satisfaction to the induction technique was evaluated next day using a verbal 11-point numeric rating scale (NRS). Patients were asked to rate their level of satisfaction between 0 and 10, with 0 corresponding to worst experience and 10 corresponding to complete satisfaction. Patients were also asked whether they would like to repeat same induction method in future or not.

Data was analyzed using SPSS version 26. Continuous data are presented as mean ± sd and analyzed using independent t test. Categorical variables are presented as number/percentages and analyzed using chi square or fisher's exact test whichever was applicable. P value ≤ 0.05 was considered significant.

## RESULTS

Total 102 ASA I and II patients undergoing elective laparoscopic surgery, 51 in each group were studied. Table 1 presents the demographic variables and duration of induction in two groups.

Changes in Heart rate (HR) and Mean arterial pressure (MAP) after induction in both the group are illustrated in Table 2.

Occurrence of tachycardia, bradycardia, hypotension and hypertension are illustrated in Table 3.

Average propofol administered during induction with titrating dose was 12.96±3.17 ml or 2.24±0.51mg/kg. Total 13 patients (25%) had experienced pain during propofol injection.

Satisfaction level, preference and cost of induction between two groups are illustrated in Table 5.

**Table 1. Demographic variables and induction time between two groups.**

<i>Variables</i>	<b>Group S (n=51)</b>	<b>Group P (n=51)</b>	<b>P Value</b>
<b>Age</b>	40.67±12.97	43.22±14.02	0.34
<b>Male</b>	19 (37.25%)	12 (23.52%)	
<b>Female</b>	32 (62.74%)	39 (76.47%)	1.32
<b>Smoking History</b>	2 (3.92%)	1(1.96%)	0.58
<b>ASA I</b>	31 (60.78%)	34 (66.66%)	
<b>ASA II</b>	20 (39.32%)	17 ((33.33%)	0.53
<b>BMI</b>	26.16±4.07	24.83±4.87	0.13
<b>Induction time in seconds</b>	53.33±17.29	72.27± 25.15	0.01

Values presented in mean±sd, number (percentage), ASA: American Society of Anaesthesiologist Physical status, BMI: Body mass index

**Table 2. Change in Heart rate and mean arterial pressure after induction**

	<b>Group P (n=51)</b>	<b>Group S(n=51)</b>	<b>P value</b>
<b>HR Baseline</b>	78.86±11.52	77.56±14.18	0.61
<b>HR after Induction</b>	78.15±11.79	78.15±12.37	0.48
<b>MAP Baseline</b>	93.47±8.88	94.33±11.12	0.66
<b>MAP after Induction</b>	81.47±11.60	85.58±13.65	0.11

Values are presented in mean±sd, analyzed with independent t test, HR: Heart rate, MAP:Mean arterial pressure

**Table 3. Hemodynamic events during induction**

<b>Hemodynamic events</b>	<b>Group P (n =51)</b>	<b>Group S (n =51)</b>	<b>P value</b>
<b>Hypertension</b>	2 (3.92%)	4 (7.84%)	0.49
<b>Hypotension</b>	24 (47.05%)	19 (37.25%)	0.31
<b>Tachycardia</b>	7 (13.72%)	5 (9.80%)	0.78
<b>Bradycardia</b>	5 (9.80%)	8 (15.68%)	0.37

Data presented as number/percentage

**Table 4. Complications during induction**

Complications	Group P (n=51)	Group S(n=51)	Pvalue
Apnoea	3 (5.88%)	2 (3.92%)	0.66
Cough	3 (5.88%)	5 (9.80%)	0.46
Involuntary Movements	14 (27.45%)	9 (17.64%)	0.23
Hiccup	1(1.96%)	0	0.31
De-saturation	1(1.96%)	0	0.31
Excessive secretions	0	3 (5.88%)	0.07
VPCs	0	1(1.96%)	0.31
<b>Total</b>	<b>22(43.13%)</b>	<b>20 (39.21%)</b>	

Data presented as number/percentage, VPCs: Ventricular premature contractions

**Table 5. Satisfaction level, preference and induction cost.**

Variables	Group P (n=51)	Group S (n=51)	P value
Satisfaction level in NRS*	8.6 ±1.47	8.7 ±1.63	0.78
<b>Preference to same induction method:</b>			
Yes	47(92.15%)	45(88.23%)	
No	0	1(1.96%)	
Could not determine	4(7.84%)	5(9.80%)	0.49
Cost of induction	1.80\$±0.44	1.6\$±0.54	0.07

Values are presented in mean±sd, NRS= Numerical Rating Scale

\*Thirteen patient in Group P and 9 patients in Group S could not rate in NRS

\$= US dollar

## DISCUSSION

We chose vital capacity induction (VCI) method with 8% sevoflurane because this method has faster onset of induction with less side effects such as cough, laryngospasm, involuntary movements in comparison to other method of inhalational induction with sevoflurane.[5-9] Similarly, induction with titrating dose requires less propofol and produces more stable hemodynamic in comparison to standard bolus dose injection.[10]

In our study, induction with Sevoflurane was significantly fast in comparison to propofol (53.33±17.29sec vs. 72.27±25.15 sec) , which is similar to that reported in a study done by

Philip K. et al. ( $56 \pm 4$  sec vs.  $92 \pm 12$  sec).[12] In contrast, other studies reported rapid induction time with propofol in comparison to sevoflurane 8% VCI ( $32-53$  sec vs.  $45-79$ sec).[3,13,14] In a study done by Priya et al. and Udayabhaskar et al. induction time was similar in both the propofol and sevoflurane group ( $38.64-41.7$ sec vs.  $44.38-51.1$ sec. ).[15,16] Different induction time even with the same method of sevoflurane 8% VCI induction might have been due to variability in the use of nitrous oxide, priming of the circuit and ability of the patient to perform the manoeuvre correctly. The slower induction with propofol, compared with above studies might be due to the differences in doses and speed of propofol injection.

After induction, heart rate (HR) remained stable but mean arterial pressure (MAP) decreased in both the groups even though both the changes are statistically insignificant. The fall in MAP was more in propofol group in comparison to sevoflurane. Similar changes in HR and MAP were reported in past studies.[11,13,15,17-19] In our study, hypotension was noted in 47% patients in propofol group and 37% patient in sevoflurane group, which is higher than that observed by Dongare et al.[20] They reported hypotension in 26% patients in propofol group and three percent in sevoflurane group. More number of patients were noted of having hypotension in our study in both the group compared with the above study was because of narrower hemodynamic range we had set as being normal. We considered fluctuations of  $\pm 15\%$  from baseline value as significant hemodynamic change in contrast to 20% in their study.

Over all complications rate during induction was slightly high in the propofol group (43.13% vs. 39.21%) which is supported by a meta-analysis with an odds ratio of 0.72 in favour of sevoflurane.[1] Apnoea and involuntary movements were noted more in patients induced with propofol as reported by other studies.[3,12,15,17,19] But the incidence of apnoea was very low in comparison to these studies and only one patient had transient de-saturation. The low rate of apnoea in our study might be due to the titrating dose of propofol used for induction. The average propofol dose required to induce patient with this method was  $2.24 \pm 0.51$ mg/kg which was similar to a study done by Thwaites et al.[11] Cough and excessive secretions were noted more in sevoflurane group similar to past studies.[17,21] Laryngospasm during induction with sevoflurane has been noted in past studies, but none occurred in our study.[19,21]

Pain on propofol injection was seen in 25% of patients. In past studies up to 69% patient had experienced pain on propofol injection.[3] The low incidence of pain on propofol injection in our study might be because of use of propofol containing intermediate- long chain triglyceride and inducing with a titrating dose.[22]

Unlike a meta-analysis which reported lower patient satisfaction rate with sevoflurane VCI technique compared with propofol (27/251 vs. 12/323), patient satisfaction rate was high in both the group in our study.[1] Majority of the patient preferred same technique in future similar to that reported by past studies.[5,11,19]

Induction with sevoflurane was cheaper as compared to propofol similar to that reported by past studies.[14,23] The cost of syringes used to inject propofol and other accessories which were used in both the group were not included in the cost. The cost of propofol induction would have further increased, if the wasted amount of the drug was also considered in the cost. The cost of induction was found cheaper in patients induced with propofol (1.20\$ vs 2.22 \$) in a study done by Singh Y et al.[5] This difference with higher cost of sevoflurane might be due to the use tidal volume breath technique and longer induction duration in their study. The limitations of our study are hemodynamic parameters were recorded only up to one minute after induction, there might be investigator bias while assessing the numeric rating score (NRS), all the patients could not rate NRS, so the actual satisfaction score might differ.

## CONCLUSION

Inhalational induction with sevoflurane 8% using vital capacity induction technique is rapid and cheap as compared with intravenous induction with 1% propofol in titrating dose. Complications during induction were insignificant and patient satisfaction was high in both the groups.

## CONFLICT OF INTEREST

None

## SOURCES OF FUNDING

None

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