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Original Research Article

A prospective randomized study for comparison of haemodynamic changes and recovery characteristics with propofol and sevoflurane anaesthesia during laparoscopic cholecystectomies

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ABSTRACT

Background: Day care laparoscopic surgical procedures are rapidly increasing nowadays. Rapid emergence and early recovery from anaesthesia with minimal complications are desired. Both propofol and sevoflurane meet above criteria and established as agents of choice in laparoscopic surgeries for induction and maintenance of anaesthesia. So this study aimed to compare sevoflurane with propofol for intraoperative haemodynamic changes with postoperative recovery profile in patient's undergone laparoscopic cholecystectomies under general anaesthesia.
Methods: In this prospective randomized study, sixty patients of either sex, 18-60 years with ASA grade 1 and 2 scheduled for laparoscopic cholecystectomies under general anaesthesia were randomly allocated into two groups. In Group S, patients were maintained on sevoflurane anaesthesia (0.5-2.5%) while in Group P, patients were maintained with propofol infusion (75-125 µg/kg/min) along with O_2 (50%) and N_2O (50%).The intraoperative haemodynamic parameters, recovery characteristics and postoperative nausea and vomiting (PONV) were observed in both groups.
Results: The mean baseline haemodynamic parameters (HR, SBP, DBP, MBP, SpO_2 and $EtCO_2$) were comparable in both groups, ($P>0.05$). No significant difference in HR was at observed any time interval, $P>0.05$, however, SBP, DBP and MBP were significantly lower in propofol group at different time intervals, $P<0.05$, but clinically not significant and patients remained haemodynamically stable in both groups. The mean time for all recovery characteristics were significantly shorter in sevoflurane group as compared to propofol group, ($P<0.01$). However the incidence of PONV was significantly more in sevoflurane group.
Conclusions: Sevoflurane can be used as an effective alternative to propofol for maintenance of anaesthesia in day care laparoscopic procedures as it has better recovery profile with stable haemodynamic parameters.

Keywords: Cholecystectomy, Haemodynamics, Laparoscopic, Propofol, Recovery characteristics, Sevoflurane

INTRODUCTION

Day care laparoscopic surgery is one of the most common surgical procedures performed and rapidly increasing nowadays. General anaesthesia is routinely provided by use of an intravenous sedative-hypnotic as an induction agent followed by inhalational agents for maintenance of anaesthesia. Widespread availability of non-pungent and rapidly acting volatile anaesthetic agents are in increasing use for induction and maintenance of general anaesthesia in these patients and are widely used in day-care surgeries. However, early recovery and postoperative nausea vomiting (PONV) depends on the anaesthetic technique being used.[1,2] The use of appropriate anaesthetic agents that provide fast and smooth induction, allow fast changes in intensity while

maintaining anaesthesia and early recovery, and that have no or minimal postoperative side effects are desirable for early hospital discharge. So based on these characteristics, for fast induction and early recovery, newer inhalation agents based on low blood/gas partition coefficients are being used as alternatives to propofol in day care anaesthetic procedures. [2-5]

Rapid emergence from anaesthesia and postoperative recovery of cognitive function as well as haemodynamic stability are important requirements of modern anaesthesia. Usually both propofol and sevoflurane meet these criteria though the clinical effects like postoperative nausea vomiting (PONV), and the recovery profile after administering propofol and sevoflurane have been studied in various outpatient operations but have not been much evaluated or studied in patients undergoing surgical procedures like cholecystectomy. These agents did not show any definite advantage of one technique over the other and needs to be studied. We hypothesized that using the less soluble volatile anaesthetic agents like sevoflurane, as alternative to propofol for maintenance of anaesthesia facilitates the ability of outpatients to achieve post anaesthesia care unit (PACU) discharge criteria on arrival in the PACU after laparoscopic surgeries. Sevoflurane has a low blood gas partition coefficient, which contributes to more rapid induction and emergence from anaesthesia than with other volatile anaesthetics in current clinical use. Propofol has been established as the intravenous agent that provides faster and smoother recovery, adequate maintenance and decreased incidence of PONV.[6-10]

So the present study has been conducted to compare sevoflurane with that of propofol infusion for maintaining anaesthesia with respect to intraoperative haemodynamic characteristics and recovery profile in patients undergoing laparoscopic cholecystectomies under general anaesthesia.

METHODS

After obtaining hospital's ethical committee's approval and written informed consent from the patient, this prospective randomized study was conducted in the department, including sixty adult patients of American Society of Anaesthesiologists (ASA) grade 1 or 2, aged 18-60 years of either sex, who were scheduled for elective laparoscopic cholecystectomies of less than 2 hours duration under general anaesthesia. All the patients were randomly allocated into one of the two groups using computer generated random number table with closed sealed envelope technique; Group S, anaesthesia was induced with propofol and maintained with sevoflurane, N_2O (50%) and O_2 (50%) and Group P, anaesthesia was induced with propofol and maintained with propofol infusion, N_2O (50%) and O_2 (50%). Patients who have known allergy with study drugs, with history of any cardiovascular, pulmonary, endocrine, renal or hepatic disease or history of hypersensitivity to halogenated anaesthetic agents, pregnant and lactating mothers were excluded from this study.

A thorough preoperative check-up with general physical examination was done along with all routine investigations like haemoglobin, renal function tests, serum electrolytes, random blood sugar, coagulation profile, chest X-ray PA view and ECG. All the patients were kept nil by mouth after the previous midnight of surgery. In the operating room, all standard monitors including non-invasive blood pressure (NIBP), pulse oximetry (SpO_2), electrocardiogram (ECG) and capnography ($EtCO_2$) were attached. After establishing intravenous access using an 18G cannula, ringer lactate was started and pre-operative vital parameters were recorded. All patients were premedicated with Inj. glycopyrrolate (0.004mg/kg), Inj. fentanyl (1 mcg/kg) and Inj. Lidocaine (1.5mg/kg) intravenously. After preoxygenation with 100% O_2 for three minutes, patients were induced with Inj. propofol (2 mg/kg) intravenously in both groups, intubation was done with Inj. succinylcholine (2mg/kg). In Group S, anaesthesia was maintained with sevoflurane, nitrous oxide (50%) and oxygen (50%), while in Group P it was maintained with propofol infusion, nitrous oxide (50%), and oxygen (50%). All patients were given intermittent positive pressure ventilation (IPPV) with 50% N_2O in oxygen and 0.5-2.5% inspired concentration of sevoflurane in Group S while propofol infusion at rate of 75-125 µg/kg/min in Group P. The infusion rate of propofol or concentrations of sevoflurane were adjusted to keep as per requirement to maintain the blood pressure and heart rate within range of 15% of the preincision values. Vecuronium was administered for muscle relaxation. Sevoflurane and propofol were discontinued 15 minutes before the end of surgery to facilitate rapid emergence from anaesthesia and nitrous oxide was discontinued at the end of surgery. Neuromuscular blockade was reversed with Inj. neostigmine 0.05 mg/kg and Inj. glycopyrrolate 0.01 mg/kg were given immediately after completion of surgery. Extubation of trachea was done after adequate recovery from the effects of neuromuscular blockade.

The time of discontinuing sevoflurane or propofol infusion was recorded. The patient was asked to open his/her eyes, respond simple verbal commands, and the time intervals from cessation of anaesthetic were recorded. Also extubation time and the time when patient was able to squeeze the hand, states his/her name were recorded. Anaesthesia time from induction to tracheal extubation and operative time from incision to closure of surgery were also recorded.

The HR, SBP, DBP, MBP, SpO_2 and $EtCO_2$ were recorded before premedication, before induction, after induction at 1, 5, 10, 15, 30, 45, 60 minutes and after extubation at 1, 5, 15, and 30 minutes. Total anaesthesia and operative time was also recorded. Complications if any like laryngospasm, apnoea, bronchospasm, postoperative nausea and vomiting (PONV), somnolence,

agitation were recorded. A simple behavioural score was employed to assess the overall recovery.[18]

- 1 = calm / cooperative / good
- 2 = drowsy but arousable
- 3 = confused / restless / disoriented
- 4 = drowsy / unable to obey command

PONV was recorded in three stages: early period (at 1 hour), intermediate (at 6 hour) and late period (at 24 hour) separately.

Patients with any kind of nausea or vomiting received rescue dose of ondansetron 4 mg iv and their post-operative antiemetic needs were recorded.

Statistical analysis

A sample size of 30 patients in each group was calculated and required to provide 80% power (β=0.2) to detect a significant difference in recovery profile and haemodynamic parameters between the two groups. Data were expressed as mean ± standard deviation and percentage. Continuous variables were analyzed using unpaired t-test and categorical variables (i.e. ASA Grade, gender) were analyzed using chi-square test. The analysis of recovery criteria, differences among groups were investigated by ANOVA variant analysis. P value <0.05 was considered as statistically significant while P value <0.01 was considered as statistically highly significant.

RESULTS

Both the groups were comparable with respect to demographic data (age, gender, weight, ASA grade and type of surgical procedure), (P>0.05) (Table 1 and 2) Both the groups were comparable in terms of operative time (P=0.72) and anaesthesia time (P=0.36), The mean values of baseline HR, SBP, DBP, MBP, SpO_2 and $EtCO_2$ were comparable in both groups, (P>0.05) (Table 3).

Table 1: Demographic data.

Characteristics		Group I (S)		Group II (P)	
		No. of patients	%	No. of patients	%
Gender	Male	04	13	03	10
	Female	26	87	27	90
ASA Grade	Grade I	23	77	22	73
	Grade II	07	23	08	27
Type of surgical procedure lap. cholecystectomy		30	100	30	100
Total no. of subjects		30	100	30	100

Table 2: Age and weight distribution in both groups.

Characteristics	Group I (S) Mean + SD	Group II (P) Mean + SD	P value	Significance
Age (years)	38.90 + 12.23	40.73 + 11.71	0.55	NS
Weight (kg)	58.90 + 8.18	60.20 + 6.39	0.32	NS

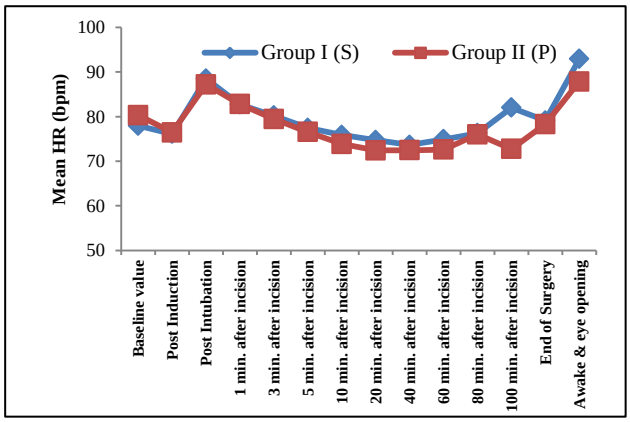

Figure 1: Intra operative heart rate (bpm) trends in both groups.

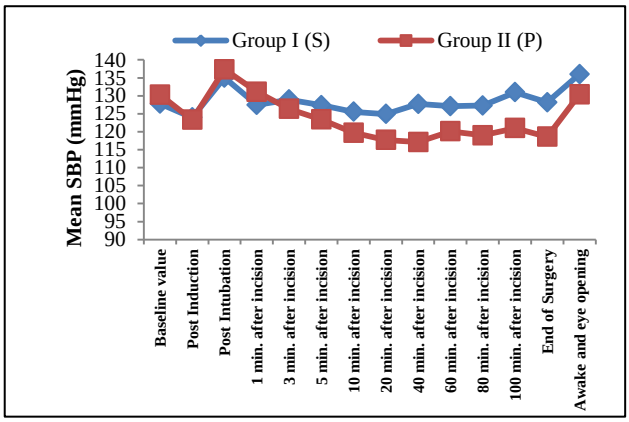

Figure 2: Intra operative systolic blood pressure (mmHg) Trends in both groups.

There was no significant difference in HR between two groups at any time interval (P>0.05) except at 100 minutes after incision (P=0.02) (Figure 1).

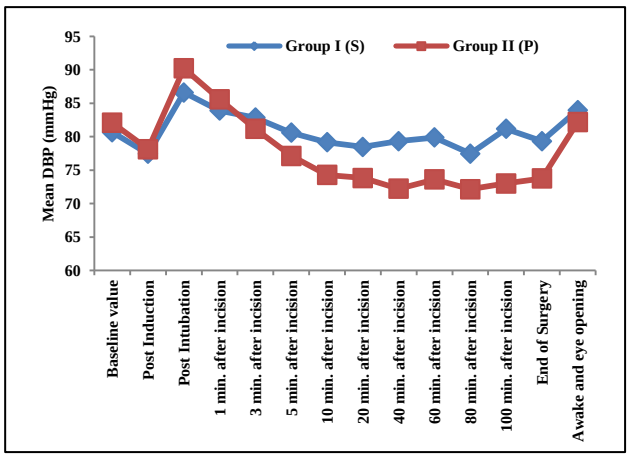

Figure 3: Intra operative diastolic blood pressure (mmHg) trends in both groups.

There was no significant difference in SpO_2 and $EtCO_2$ between the two groups at any time interval (P>0.05). The SBP was significantly low in patients of Group P intraoperatively from 10 minutes after incision till the end of surgery, (P<0.05) (Figure 2). The DBP was significantly low in Group P patients intraoperatively from 5 minutes after incision till 60 minutes after incision, P<0.05 (Figure 3).

Similarly MBP was significantly low in Group P patients from 20 minutes after incision till 60 minutes after incision, P<0.05 (Figure 4). The incidence of Score 1 to behavioural score for assessment of overall recovery was 19 (63%) patients in Group S while 21 (70%) patients in Group P. Score 1 was most favourable score. The incidence of Score 2 to behavioural score for assessment of overall recovery was 8 (27%) patients in Group S while 7 (23%) patients in Group P. The incidence of Score 3 to behavioural score for assessment of overall recovery was 3 (10%) patients in Group S while 2 (7%) patients in Group P. There were no patients for Score 4 in each group (Table 4).

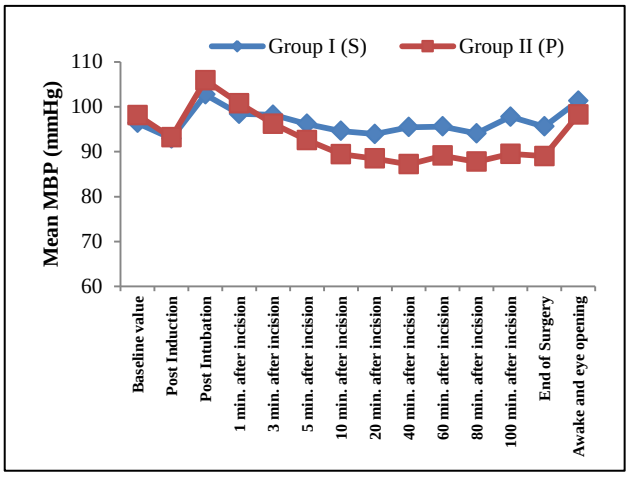

Figure 4: Intra operative mean blood pressure (mmHg) trends in both groups.

Table 4: Behavioural score for recovery in both groups.

Score	Group I (S) No. of patients (%)	Group II (P) No. of patients (%)	Total (n = 60)
1	19 (63%)	21 (70%)	70 (67%)
2	8 (27%)	7 (23%)	15 (25%)
3	3 (10%)	2 (7%)	5 (8%)
4	0 (0%)	0 (0%)	0 (0%)

Table 5: Recovery characteristics in time intervals (in minutes) in both groups.

Recovery characteristics	Group I (S) Mean + SD	Group II (P) Mean + SD	P value	Significance
Eye opening	7.67 + 2.63	10.27 + 2.66	0.00034	HS
Responding simple verbal commands	9.30 + 2.78	11.93 + 2.73	0.0004	HS
Hand squeezing	10.97 + 3.08	14.53 + 3.40	0.00007	HS
Tracheal extubation	11.70 + 3.35	15.33 + 3.38	0.0001	HS
Stating name	12.97 + 3.42	17.43 + 3.78	0.00001	HS

The mean time for various recovery characteristics (Eye opening, Responding simple verbal commands, Hand squeezing, Tracheal extubation, Stating name) were significantly less in Group S in comparison to Group P (P value <0.01) (Table 5). In Group S, the total number of patients with PONV were 18 (60%) while in Group P the total number of patients with PONV were 5 (17%) during 24 hours after surgery observation period.

The incidence of PONV was significantly high in Group S patients at early (1 hour) and intermediate (6 hour) recovery period, while it was comparable in both groups at late (24 hour) recovery period.

DISCUSSION

Laparoscopic procedures are rapidly increasing nowadays on outpatient basis surgical operations because of shorter hospital stay and reduced health cost.[3] Faster induction, haemodynamic stability, early recovery from anaesthesia and return of cognitive function are prerequisites of day care anaesthesia.[7] Propofol is preferred intravenous ultra-short acting agent in day care surgeries and have smooth induction and rapid recovery of consciousness with some antiemetic properties.[11] Sevoflurane is also widely used as an inhalational induction agent as it is pleasant to inhale and has less airway irritation with low blood gas partition coefficient which contributes to more rapid induction and emergence from anaesthesia than with other volatile anaesthetics in clinical anaesthesia.[12,13]

So both propofol and sevoflurane have smooth and rapid anaesthetic induction and maintenance with shorter recovery providing adequate anaesthetic conditions for day care anaesthesia.[13] This study was designed and based on the hypothesis that using the less soluble volatile anaesthetic agent, sevoflurane, can be used as a better alternative to propofol for maintenance of anaesthesia in patients undergoing laparoscopic cholecystectomy in day care anaesthesia.

There was no significant difference in the two groups with regard to mean age and weight, (P>0.05). Both the groups were comparable in terms of gender distribution although majority of patients were females. This could be due to inclusion of cholecystectomy which is a more common procedure in females. Mean baseline vital parameters like heart rate, systolic blood pressure, diastolic blood pressure, mean blood pressure, end-tidal carbon dioxide, peripheral oxygen saturation values were comparable in both the groups,(P>0.05). In the present study, there was no significant difference in the two groups with respect to operative time and anaesthesia time.

There was no significant difference in HR between two groups at any time interval, (P>0.05). However, Juckenhöfel S, et al and Yao XH et al observed a significant decrease in mean heart rate during maintenance of anaesthesia with propofol, (P<0.05), but not with sevoflurane.[14,15] MBP was significantly low in patients of group P as compared to group S, in present study, (P<0.01). Fredman B et al, Smith I et al, A Thwaites A et al, Jellish WS et al also compared the effects of sevoflurane versus propofol in the induction and maintenance of anaesthesia in adult patients and observed that mean arterial pressure was significantly lower after induction in propofol group as compared to sevoflurane.[8,9,10,16] The incidence of hypotension and bradycardia was slightly greater in induction with propofol while the incidence of tachycardia was seen in equal number of patients at any stage in both the groups in our study. The tachycardia could be controlled with rise in inspired concentration of volatile anaesthetic agent while the hypotension associated with propofol may be of limited significance for healthy patients, however it may be detrimental in the elderly and those with coronary artery disease. Mean BP was significantly low in Group P patients from 20 minutes after incision. One patient in Group S and 4 patients in Group P were reported hypotension while 3 patients in Group S and 1 patient in Group P were reported hypertension but all other patients were haemodynamically stable in both groups intraoperatively similar to the studies done by Orhon ZN et al, Joo HS et al, Shah A et al, however heart rate and blood pressure was decreased more in propofol group otherwise patients remained haemodynamically stable throughout the surgery.[1,5,17]

During maintenance of anaesthesia with propofol infusion there is an expected decrease in 20-30% of systolic blood pressure from the pre-induction values while the heart rate may either increase, decrease or remain unchanged. So increasing the infusion rate of propofol might produce greater decrease in arterial blood pressure. This property of propofol helps in controlling the transient hypertensive response to CO_2 insufflation and noxious surgical stimuli during intraoperative period particularly in laparoscopic surgeries.

Samantaray A et al observed that the intraoperative haemodynamic parameters like heart rate and blood pressure were within acceptable range in both the groups during his study on spine surgery, although both the drugs effectively counteracted transient hypertensive response.[18] On emergence from anaesthesia the behavioural score did not differ much in both the groups. As both the groups were inhomogeneous they assumed that this change in haemodynamics was related to the anaesthetic technique. On the contrary, Husedzinovic I et al did not find any significant difference in haemodynamic parameters between propofol and sevoflurane groups in patients undergoing open cholecystectomy.[19]

In terms of behavioural score for assessment of overall recovery, both the groups were comparable with maximum patients having most favourable score 1. Regarding postoperative recovery characteristics, the emergence times from discontinuation of the primary maintenance anaesthesia to spontaneous eye opening, response to simple verbal commands, hand squeezing , extubation of trachea and stating names were significantly less in Group S in comparison to Group P, (P <0.01).

Orhan ZN et al evaluated the comparative effects of propofol infusion versus sevoflurane for maintenance of anaesthesia with respect to recovery characteristics in

patients undergoing percutaneous nephrolithotomy (PCNL).[17] Early recovery times [spontaneous respiration (P=0.002), eye opening (P=0.006), extubation (P=0.013), obey commands (P<0.05), hand squeezing (P=0.005)] were significantly longer in propofol group and they concluded that maintenance of anaesthesia with sevoflurane is associated with faster recovery than anaesthesia with propofol, which is similar to the findings of present study. Similarly Wandel C, et al observed that patients who received sevoflurane were extubated at an earlier stage than those receiving propofol (6.6 vs 9.8 min), and the times to eye opening (7.2 vs 12.6 min) and hand squeezing (8.2 vs 13.8 min) were also shorter.[20] Similarly Singh SK et al observed that sevoflurane group had better recovery profile with better cognitive function as compared to propofol group, the percentage of patients judged fast-track eligible on arrival in the PACU was significantly higher in the sevoflurane group (75% vs 26%).[2] The results of present study was also concurred with Yao XH et al and Shah A et al who observed that emergence and recovery after maintenance with sevoflurane–N_2O (group-I) was significantly faster than propofol-N_2O (group-II).[1,15] In some other studies, investigators also observed a shorter recovery time in patients given sevoflurane anaesthesia, which is similar to the findings of present study.

Larsen et al and Robinson et al found that propofol group had better early recovery profile with better cognitive function in intermediate recovery phase as compared to sevoflurane group.[6,21]

The incidence of PONV, however, was significantly lower in group P than in group S, (P<0.05). Philip BK et al and Shinn HK et al conducted a study in ambulatory surgeries and found that the incidence of PONV was low with propofol group.[22,23] This finding was in accordance with present study. The incidence was significantly lower in group P than in group S, patients at early (1 hour) and intermediate (6 hour) recovery period (P<0.05) Similarly Apfel et al noted sevoflurane like any other inhalational anaesthetics is associated with PONV which is caused mainly by the emetogenic effects of volatile anaesthetics and whereas the incidence of PONV is less in propofol based anaesthesia because of its intrinsic antiemetic properties.[24]

On the contrary, Gupta et al reported that no time difference was found in eye opening time between sevoflurane and propofol in their systematic review, but the time period to obeying commands was faster in the sevoflurane group.[25]

Samantaray A et al observed that maintenance of anaesthesia with sevoflurane was associated with PONV as with any other inhalational anaesthetic.[18] Similarly Shinn HK et al compared the incidence and degree of PONV in patients who received general anaesthesia with propofol and those with sevoflurane.[23] The propofol group had a statistically lower incidence of PONV. These findings were supported by present study.

In early postoperative period, only one patient had vomiting in the propofol group and only 17% patients had complained of nausea and vomiting in 24 hours period, while 60% patients in sevoflurane group had PONV however the reported incidence is 70%. Routine PONV prophylaxis has been recommended for patients at high risk for PONV. Although, PONV may become a significant complication, not only by reducing the patient's satisfaction but also by increasing the cost. So prophylactic use of antiemetics is mandatory in laparoscopic cholecystectomies however prophylactic use of dexamethasone can also reduce the occurrence of PONV.

CONCLUSION

The haemodynamic stability and recovery profile were significantly better in patients after maintenance with sevoflurane inhalation as compared to propofol infusion. Sevoflurane is considered as a useful alternative to propofol in providing anaesthesia in laparoscopic cholecystectomies, especially in patients where rapid emergence and recovery of cognitive function is very much desired along with stable haemodynamic parameters, however antiemetic prophylaxis is needed in maintenance with sevoflurane anaesthesia.

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