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COMPARISON OF THE INTRAOPERATIVE HEMODYNAMIC PARAMETERS AND RECOVERY CHARACTERISTICS OF DESFLURANE AND SEVOFLURANE IN PATIENTS UNDERGOING LAPAROSCOPIC CHOLECYSTECTOMY

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ABSTRACT

Background: Laparoscopic procedures have emerged as the preferred standard of care for a majority of surgical conditions and are extensively employed in daycare surgeries. Beyond the surgical technique itself, the choice of anesthetic agents significantly influences favorable clinical outcomes. This study aimed to evaluate intraoperative hemodynamic parameters and recovery profiles associated with the use of desflurane and sevoflurane.

Materials and Methods: This randomized controlled trial involved 60 patients, divided equally between two groups: one receiving desflurane and the other sevoflurane. Participants aged between 18 and 45 years underwent laparoscopic cholecystectomy at a tertiary care center in central India. Approval from the institutional ethics committee was obtained, along with informed consent from all patients. Hemodynamic parameters were monitored both preoperatively and intraoperatively, while the time to spontaneous breathing, extubation, and postoperative complications were documented for both groups.

Results: The demographic profiles and baseline characteristics of the two groups were comparable, with most participants being female in both groups. The study did not reveal any significant differences in hemodynamic parameters between the groups. The desflurane group demonstrated a 1.73-fold faster achievement of spontaneous breathing and a 1.4-fold faster extubation time compared to the sevoflurane group. No notable postoperative complications were observed in either group, and the average duration of hospital stay was similar across both groups.

Conclusion: This study concludes that desflurane and sevoflurane exhibit comparable hemodynamic profiles during laparoscopic cholecystectomy. However, desflurane demonstrates superiority in facilitating earlier recovery of spontaneous breathing, responsiveness to verbal commands or eye-opening, as well as faster extubation times.

Keywords: Intraoperative hemodynamic parameters, recovery characteristics, desflurane, sevoflurane, laparoscopic cholecystectomy.

INTRODUCTION

Laparoscopic surgery has become the standard approach for managing cholelithiasis, offering several notable benefits.[1] These include quicker recovery of cognitive function, early mobilization, and a reduced incidence of postoperative complications, such as postoperative nausea and vomiting (PONV). These advantages make it a widely preferred method, particularly for daycare procedures.[2,3] In addition to surgical techniques, the selection of anesthetic agents also plays a crucial role in achieving favorable outcomes. Anesthetic agents that ensure rapid and smooth induction, maintain stable hemodynamics during anesthesia, and promote early recovery without postoperative side effects are particularly beneficial for such procedures.[4]

The introduction of modern inhalational agents, such as sevoflurane and desflurane, has resulted in improved pharmacokinetic profiles compared to conventional anaesthetic agents, facilitating rapid and smooth emergence from anesthesia. While a few studies have compared the effects of desflurane and sevoflurane on intraoperative hemodynamics and recovery characteristics during laparoscopic procedures, findings suggest desflurane exhibits a superior recovery profile compared to sevoflurane.[5,6] However, the limited availability of randomized controlled trials (RCTs) in the existing literature underscores the need for further research. The present study was designed as a double-blind randomized controlled trial to assess and compare intraoperative hemodynamic parameters and recovery features between desflurane and sevoflurane. The primary aim was to evaluate intraoperative hemodynamic parameters, while the secondary aim focused on comparing recovery times, including motor and cognitive function outcomes.

MATERIALS AND METHODS

This study was designed as a prospective, double-blind, randomized controlled trial involving 60 participants aged 18 to 45 years, classified as ASA grade 1 or 2, who were scheduled for elective laparoscopic cholecystectomy at a tertiary care centre in central India. Approval was obtained from the institutional ethics committee, and informed consents were obtained from all participants prior to their enrollment in the study.

Participants were randomized into two groups using a computer-generated allocation table: Group 1 received desflurane (3%-6%), while Group 2 was administered sevoflurane (1%-2%). Exclusion criteria encompassed individuals with a history of drug allergies, severe obesity, moderate to severe cardiopulmonary, hepatic, or renal dysfunction, endocrine or neurological disorders, as well as those who declined treatment. Additionally, patients requiring intraoperative conversion from laparoscopic to open surgery were excluded from the final analysis.

All patients underwent pre-anesthetic evaluations conducted by anesthesiologists not involved in the study. On the day of surgery, standard monitors, including electrocardiograms, non-invasive blood pressure devices, and pulse oximeters, were applied in the operating room in accordance with ASA guidelines, and baseline parameters were documented. Anesthesia was administered following institutional protocols. After adequate preoxygenation, all patients received midazolam at a dosage of 0.03 mg/kg and fentanyl citrate at 2 mcg/kg. Propofol, at a dose of 1.5-2.5 mg/kg, was used as the induction agent, and neuromuscular blockade was achieved with atracurium at 0.5 mg/kg. The airway was secured using an appropriately sized endotracheal tube. During the intraoperative period, all patients were mechanically ventilated using a closed circuit, with EtCO2 levels maintained within the range of 35-40 mmHg. The concentration of volatile anesthetic agents was adjusted to sustain a minimum alveolar concentration (MAC) of 1, while hemodynamic variables were kept within 15% of baseline pre-induction values.

Following the conclusion of laparoscopic surgery, the administration of volatile anesthetic agents was discontinued. Neuromuscular blockade was reversed using neostigmine at a dosage of 50 mcg/kg in combination with glycopyrrolate at 10 mcg/kg, after the onset of spontaneous respiratory efforts. Extubation was performed once patients had adequately recovered from the neuromuscular agent's effects and demonstrated responsiveness to verbal commands. Hemodynamic parameters, along with SpO2 levels, were monitored preoperatively, at 5-minute intervals post-induction, and subsequently at 15-minute intervals during the surgical procedure. The time required for the restoration of spontaneous breathing and extubation after cessation of anesthesia was documented. Postoperative observations included complications such as headache, postoperative nausea and vomiting (PONV), analgesic requirements, and the duration of hospital stay.

Sample size calculation and statistical Analysis

The sample size determination was based on the findings reported by Ortiz et al.[7], considering all categorical variables with a 95% confidence interval and a study power of 80%. The calculated sample size for each group was 27, with an additional allowance for a 10% dropout rate during the study, leading to a final sample size of 30 participants per group. Qualitative data were represented as percentages and proportions, while quantitative data were presented as mean values with standard deviations. Comparisons of continuous variables between groups were performed using paired t-tests, and categorical variables were analyzed using chi-square and Mann–Whitney U tests. A p-value of less

than 0.05 was deemed statistically significant. All statistical analyses were conducted using SPSS software, version 15.

RESULTS

A total of 65 patients scheduled for laparoscopic cholecystectomy who met the inclusion criteria, 5 were excluded from the study due to the conversion of the laparoscopic procedure to open cholecystectomy. Finally, we randomly divided the 60 patients meeting the inclusion criteria into two groups. (Table 1) outlines the demographic profiles and baseline characteristics of the study participants. No statistically significant differences in age, body weight, duration of surgery, or ASA-PS classification appeared between the groups.

Table 1: Comparison of Demographic and Baseline Characteristics

SN	Characteristic	Group I (n=30)		Group II (n=30)		Statistical significance	
		No.	%	No.	%	χ^2	'p'
1.	Mean Age±SD (Range) in years	33.77±8.48 (21-45)		36.47±6.83 (21-45)		t=1.359; p=0.179	
2.	Gender						
	Male	7	23.3	11	36.7	1.270	0.260
	Female	23	76.7	19	63.3		
3.	Mean body weight±SD (Range) in kg	62.93±7.00 (50-80)		64.27±8.10 (45-80)		t=0.682; p=0.498	
4.	Mean duration of surgery±SD (Range) in min	100.37±14.92 (70-130)		100.83±16.35 (70-130)		t=0.115; p=0.908	
5.	ASA Grade						
	I	20	66.7	18	60.0	0.287	0.592
	II	10	33.3	12	40.0		

The majority of participants in both groups were female, with the mean surgery duration recorded as 100.37 ± 14.92 minutes in group 1 and 100.83 ± 16.35 minutes in group 2. A comparison of SBP across various time intervals between the groups was done. Statistically significant decreases in SBP appeared in both groups during intubation, incision, and at 5, 10, and 120 minutes ($p < 0.05$); however, preoperative SBP values showed no statistically significant differences between the groups ($p>0.05$).(Table2),(figure1)

Table 2: Within Group evaluation of SBP change from baseline at different time intervals (Paired 't'-test)

SN	Time interval	Group I (n=30)					Group II (n=30)				
		Mean Change	SD of change	% Change	't'	'p'	Mean Change	SD of change	% Change	't'	'p'
1.	At intubation	-15.33	4.88	-12.02	17.21	<0.001	-15.73	4.75	-12.21	18.15	<0.001
2.	At incision	-11.60	8.13	-9.10	7.82	<0.001	-11.40	7.41	-8.85	8.42	<0.001
3.	5 min	-6.40	8.48	-5.02	4.14	<0.001	-6.33	7.95	-4.91	4.36	<0.001
4.	10 min	-5.47	11.33	-4.29	2.64	0.013	-6.33	11.70	-4.91	2.97	0.006
5.	15 min	-3.20	11.60	-2.51	1.51	0.142	-2.47	11.04	-1.91	1.22	0.231
6.	30 min	-0.47	13.72	-0.37	0.19	0.854	0.33	12.61	0.26	-0.14	0.886
7.	45 min	-1.33	11.44	-1.05	0.64	0.528	-4.33	10.12	-3.36	2.35	0.026
8.	60 min	2.47	11.25	1.93	-1.20	0.239	1.00	11.94	0.78	-0.46	0.650
9.	75 min	3.00	8.11	2.35	-2.03	0.052	3.53	7.05	2.74	-2.75	0.010
10.	90 min	0.87	9.54	0.68	-0.50	0.622	-0.67	7.53	-0.52	0.49	0.631
11.	105 min	0.55	12.16	0.43	-0.24	0.809	-1.50	11.78	-1.16	0.67	0.506
12.	120 min	-6.50	11.26	-5.20	2.71	0.013	-9.08	12.08	-6.92	3.69	0.001
13.	135 min	0.77	11.90	0.62	-0.23	0.820	-1.57	13.32	-1.22	0.44	0.666
14.	150 min	1.50	6.40	1.19	-0.47	0.671	-3.20	13.46	-2.41	0.53	0.623

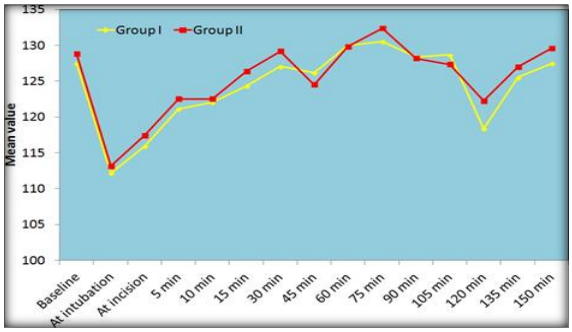

Figure 1: Mean value variation of SBP at different time variaton

A comparative analysis of diastolic blood pressure (DBP) between the two groups revealed a significant decrease at intubation, incision, and the 5-minute mark. (Table 3) (figure 2) Heart rate comparisons showed a notable increase at the 60-minute and 75-minute intervals in Group 1. Group 2 showed significant heart rate variations at the incision, at 10 minutes, and at several intervals between 30 and 120 minutes ($p < 0.05$). However, these changes did not reach statistical significance. (Table 4).

Table 3: Within Group evaluation of DBP change from baseline at different time intervals (Paired 't'-test)

SN	Time interval	Group I (n=30)					Group II (n=30)				
		Mean Change	SD of change	% Change	't'	'p'	Mean Change	SD of change	% Change	't'	'p'
1.	At intubation	-8.13	6.54	-10.22	6.81	<0.001	-7.33	6.35	-9.16	6.32	<0.001
2.	At incision	-5.73	6.38	-7.20	4.92	<0.001	-3.27	5.69	-4.08	3.14	0.004
3.	5 min	-4.67	8.47	-5.86	3.02	0.005	-5.47	6.32	-6.83	4.74	<0.001
4.	10 min	-1.67	8.63	-2.09	1.06	0.299	-2.00	6.56	-2.50	1.67	0.106
5.	15 min	-3.20	8.78	-4.02	2.00	0.055	-2.53	7.33	-3.16	1.89	0.068
6.	30 min	-0.47	7.61	-0.59	0.34	0.739	-1.07	6.21	-1.33	0.94	0.354
7.	45 min	0.27	8.15	0.34	-0.18	0.859	-0.47	7.06	-0.58	0.36	0.720
8.	60 min	0.07	6.72	0.08	-0.05	0.957	-1.07	7.12	-1.33	0.82	0.419
9.	75 min	0.40	7.42	0.50	-0.30	0.770	2.13	7.66	2.66	-1.53	0.138
10.	90 min	2.40	7.07	3.02	-1.86	0.073	2.60	6.32	3.25	-2.25	0.032
11.	105 min	2.07	8.92	2.60	-1.25	0.222	2.86	6.10	3.55	-2.48	0.020
12.	120 min	1.77	7.34	2.25	-1.13	0.270	-1.00	8.40	-1.22	0.58	0.565
13.	135 min	2.77	7.69	3.58	-1.30	0.219	-1.00	8.72	-1.24	0.43	0.675
14.	150 min	4.50	9.15	5.88	-0.98	0.398	-1.20	13.31	-1.47	0.20	0.850

Table 4: Between Group Comparison of Heart Rate at different time intervals

SN	Time interval	Group I (n=30)			Group II (n=30)			Statistical significance	
		n	Mean	SD	n	Mean	SD	't'	'p'
1.	Baseline	30	80.23	6.77	30	78.20	6.31	1.204	0.234
2.	At intubation	30	80.27	7.37	30	80.60	6.48	-0.186	0.853
3.	At incision	30	81.47	6.37	30	81.80	6.46	-0.201	0.841
4.	5 min	30	81.80	5.69	30	80.60	5.46	0.833	0.408
5.	10 min	30	81.80	7.47	30	82.80	6.57	-0.550	0.584
6.	15 min	30	78.93	6.14	30	79.80	6.04	-0.551	0.584
7.	30 min	30	82.67	4.68	30	83.80	4.96	-0.910	0.367
8.	45 min	30	81.67	5.66	30	82.13	5.20	-0.333	0.741
9.	60 min	30	83.47	4.00	30	83.93	3.91	-0.457	0.649
10.	75 min	30	83.53	5.93	30	85.53	8.27	-1.077	0.286
11.	90 min	30	83.40	7.43	30	84.67	8.23	-0.626	0.534
12.	105 min	29	81.21	6.93	28	82.11	6.53	-0.505	0.616
13.	120 min	22	80.82	7.40	24	82.25	6.52	-0.698	0.489
14.	135 min	13	81.08	9.00	14	78.00	8.11	0.934	0.359
15.	150 min	4	80.00	4.90	5	77.20	5.76	0.772	0.466

Table 5: Between Group comparison of Recovery Characteristics

SN	Characteristic	Group I (n=30)		Group II (n=30)		Statistical significance	
		Mean	SD	Mean	SD	't'	'p'
1.	Spontaneous breathing (min)	4.63	1.10	8.03	1.22	11.36	<0.001
2.	Response to verbal command and Eye opening (min)	6.03	1.16	9.10	1.13	10.40	<0.001
3.	Extubation (min)	7.40	0.89	10.13	1.04	10.90	<0.001
4.	Duration of hospital stay (hrs)	10.23	2.66	10.37	2.63	0.195	0.846

All recovery characteristics, such as spontaneous breathing, response to verbal commands, and extubation time, were significantly delayed in group 2 compared to those in group 1 ($p < 0.05$). In contrast, the duration of hospital stay in both groups was similar and statistically insignificant ($p > 0.05$) (table 5). Both groups experienced the same incidences of PONV and headache; neither group experienced desaturation or cardiac arrest (table 6).

Table 6: Between Group comparison of Side Effects

SN	Characteristic	Group I (n=30)		Group II (n=30)		Statistical significance	
		No.	%	No.	%	χ^2	'p'
1.	Headache	1	3.3	0	0	1.017	0.313
2.	Nausea/ vomiting	3	10.0	6	20.0	1.176	0.278
3.	First hour analgesic eed	4	13.3	5	16.7	0.131	0.718

Figure 2: Mean value variation of DBP at different time variaton

DISCUSSION

Laparoscopic cholecystectomy has gained widespread acceptance as a standard surgical approach, effectively transitioning the procedure into a daycare surgery by minimizing postoperative recovery time and addressing complications associated with traditional open cholecystectomy. Multiple advancements in surgical techniques and anesthetic management enhanced procedural success rates and reduced hospital stays. To further mitigate postoperative complications, thorough monitoring of all patients in the post-anesthetic care unit remains essential. The introduction of newer anesthetic agents is necessary to optimize anesthesia maintenance throughout the surgical procedure. [8,9]

The primary objective of this study was to assess and compare intraoperative hemodynamic stability and postoperative recovery profiles associated with sevoflurane and desflurane in patients undergoing laparoscopic cholecystectomy. A comparative analysis of these anesthetic agents in terms of postoperative recovery characteristics serves as a foundation for determining the more suitable option for clinical use.

In this study, the demographic characteristics of all 60 patients, including age, ASA classification, and baseline vital parameters, were comparable, with no statistically significant differences observed between the groups. Both groups showed a higher proportion of female participants; this is likely because of the higher prevalence of cholelithiasis in females. Previous research has suggested that women in the reproductive age group are susceptible to developing cholelithiasis.[10]

The hemodynamic parameters observed in this study did not show significant differences between the two groups, aligning with findings from previous research involving gastrointestinal, gynecological, and urological surgeries of varying durations.[5,9,11-17] A meta-analysis assessing the efficacy of sevoflurane and desflurane as maintenance anesthetic agents in ambulatory surgical procedures did not report notable concerns regarding hemodynamic stability.[18] These findings suggest both agents exhibit a favorable safety profile for laparoscopic procedures. Their helpful pharmacokinetic properties and dose-dependent autonomic reflex compensation for systemic vasodilation ensured stable cardiac output, thus explaining their intraoperative hemodynamic stability. [19,20]

The present study identified a significant difference between desflurane and sevoflurane regarding the restoration of spontaneous breathing, responsiveness to verbal commands or eye-opening, and extubation time. Patients in the desflurane group demonstrated a 1.73-fold faster return to spontaneous breathing compared to the sevoflurane group, while extubation time was 1.4 times quicker with desflurane. Across all measured recovery outcomes, desflurane facilitated a significantly shorter recovery duration, being approximately 1.5 times faster than sevoflurane. These findings align with previous research, which has consistently reported earlier recovery in patients receiving desflurane compared to sevoflurane anesthesia across various surgical procedures and age groups. [11-18] The superior recovery profile of desflurane can be attributed to its lower blood/gas and fat/blood partition coefficients, which enhance its rapid elimination from the body, promoting quicker postoperative recovery. Desflurane is favored over sevoflurane for optimizing early recovery in the postoperative period, a conclusion supported by prior studies. [5,9,11-17]

In the present study, postoperative nausea and vomiting (PONV), headache, and the requirement for analgesics during the first postoperative hour were documented. However, no significant differences were observed between the two groups for these outcomes. This observation aligns with findings from most published studies on the use of these anesthetic agents in daycare procedures, which similarly indicate no substantial differences between the groups, aside from occasional incidental variations.[21,22]

Although desflurane facilitated earlier recovery compared to sevoflurane, it did not have an impact on discharge time or the duration of hospital stay. In this study, the average hospital stay was 10.23 ± 2.66 hours in the desflurane group and 10.37 ± 2.63 hours in the sevoflurane group, with no statistically significant difference between the two. These findings are consistent with previous research involving patients with diverse demographic profiles and undergoing various procedures. Despite its superior recovery profile, the use of desflurane did not influence the overall duration of hospitalization. [15,16,23,24,25,26]

Limitation

The sample size of the study group was small, which may have affected the findings of the study. Using MAC as an endpoint to titrate the volatile anesthetic might have led to investigator bias. Late recovery profiles, such as cognitive and psychomotor profiles, which had a significant

impact on hospital stay, were not included in the study.

CONCLUSION

The results of the current study indicate that desflurane and sevoflurane demonstrate similar hemodynamic profiles during laparoscopic cholecystectomy. However, desflurane shows superior efficacy in facilitating earlier restoration of spontaneous breathing, responsiveness to verbal commands or eye-opening, and shorter extubation times. Consequently, desflurane may be considered preferable to sevoflurane in such procedures. Nonetheless, further research involving larger sample sizes is necessary to establish definitive clinical recommendations.

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