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Comparison of Hemodynamic Stability Between Combined Epidural-General Anesthesia and General Anesthesia Alone During Laparoscopic Surgeries

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ABS TRAC T

Background: Laparoscopic surgeries are associated with unique hemodynamic challenges due to the pneumoperitoneum-induced changes in cardiovascular physiology. Combined epidural-general anesthesia (CEGA) has been proposed as an alternative technique to mitigate these hemodynamic responses. This study aimed to compare the hemodynamic stability and analgesic requirements between CEGA and general anesthesia (GA) alone in patients undergoing laparoscopic surgeries.

Methods: A prospective observational study was conducted on 70 adult patients scheduled for elective laparoscopic surgery. The patients were allocated into two groups: GA group (n=35) and CEGA group (n=35). Hemodynamic parameters, including heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP), were monitored at various time points during the perioperative period. Analgesic requirements were also assessed.

Results: The mean heart rate was significantly lower in the CEGA group at 40 and 50 minutes after insufflation compared to the GA group ($P < 0.05$). The mean SBP, DBP, and MAP were significantly lower in the CEGA group during the capnoperitoneum period and in the post-operative period ($P < 0.05$). The analgesic requirements were also significantly lower in the CEGA group compared to the GA group ($P < 0.001$).

Conclusion: CEGA provided better hemodynamic stability and reduced analgesic requirements compared to GA alone in patients undergoing laparoscopic surgeries. These findings suggest that CEGA can be a preferred anesthetic technique for laparoscopic surgeries, particularly in patients at high risk of hemodynamic instability.

Keywords: *Combined epidural-general anesthesia, general anesthesia, laparoscopic surgery, hemodynamic stability, analgesic requirements.*

INTRODUCTION

Laparoscopic surgery has gained widespread acceptance due to its minimally invasive nature, reduced postoperative pain, shorter hospital stays, and faster recovery compared to open surgery (1). However, laparoscopic procedures are associated with unique hemodynamic changes that can pose challenges for anesthesiologists (2). The pneumoperitoneum created during laparoscopy results in increased intra-abdominal pressure, which can lead to alterations in cardiovascular and respiratory physiology (3).

General anesthesia (GA) is the most commonly used anesthetic technique for laparoscopic surgeries (4). While GA provides adequate anesthesia and muscle relaxation, it may not effectively attenuate the hemodynamic response to pneumoperitoneum (5). The stress response to surgery and the increased intra-abdominal pressure can lead to tachycardia, hypertension, and increased systemic vascular resistance (6). These hemodynamic changes may be particularly concerning in patients with pre-existing cardiovascular comorbidities (7).

Combined epidural-general anesthesia (CEGA) has been proposed as an alternative technique to mitigate the hemodynamic response during laparoscopic surgeries (8). CEGA involves the administration of epidural anesthesia in combination with GA. The epidural component provides segmental blockade of the sympathetic nervous system, which can attenuate the neuroendocrine stress response to surgery (9). By reducing the sympathetic outflow, CEGA has the

potential to maintain hemodynamic stability during pneumoperitoneum (10).

Several studies have investigated the hemodynamic effects of CEGA compared to GA alone in laparoscopic surgeries. A randomized controlled trial by Agarwal et al. found that patients in the CEGA group had significantly lower heart rate and mean arterial pressure during pneumoperitoneum compared to those in the GA group (11). Similarly, a study by Sen et al. demonstrated that CEGA was associated with better hemodynamic stability and reduced anesthetic requirements compared to GA alone (12).

The mechanism by which CEGA attenuates the hemodynamic response is multifactorial. The epidural block inhibits the afferent neural impulses from the surgical site, reducing the neuroendocrine stress response (13). Additionally, the sympathetic blockade dilates the blood vessels in the lower half of the body, leading to a reduction in systemic vascular resistance and afterload (14). This can help maintain cardiac output and prevent excessive increases in blood pressure during pneumoperitoneum (15).

Despite the potential benefits of CEGA, its use in laparoscopic surgeries remains controversial. Some studies have reported no significant differences in hemodynamic parameters between CEGA and GA groups (16). There are also concerns regarding the potential complications associated with epidural anesthesia, such as hypotension, bradycardia, and respiratory depression (17). Furthermore, the additional time required for epidural catheter placement and the learning curve associated with the technique may limit its widespread adoption (18).

In light of the conflicting evidence and ongoing debate, further research is needed to clarify the role of CEGA in maintaining hemodynamic stability during laparoscopic surgeries. Comparative studies with larger sample sizes and well-defined outcome measures are necessary to determine the efficacy and safety of CEGA compared to GA alone. Additionally, the impact of CEGA on postoperative analgesia, recovery time, and patient satisfaction should be explored to provide a comprehensive assessment of its potential benefits.

Laparoscopic surgeries present unique challenges for anesthesiologists in terms of maintaining hemodynamic stability. While GA is the standard anesthetic technique, CEGA has emerged as a promising alternative to attenuate the hemodynamic response to pneumoperitoneum. However, the evidence regarding the superiority of CEGA over GA remains inconclusive. Further research is warranted to establish the optimal anesthetic approach for laparoscopic surgeries, taking into consideration patient safety, hemodynamic stability, and postoperative outcomes.

AIMS AND OBJECTIVES

The primary aim of this study was to assess the efficacy of combined epidural and general anesthesia (CEGA) in attenuating hemodynamic responses and reducing analgesic drug requirements during the perioperative period in patients undergoing laparoscopic surgeries. The specific objectives were to compare the hemodynamic stability and intraoperative analgesic and anesthetic drug requirements between patients receiving CEGA and those receiving general anesthesia (GA) alone. The secondary objectives included evaluating postoperative analgesic requirements in the first 24 hours and comparing side effects and complications related to CEGA versus GA in laparoscopic surgeries.

MATERIAL AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Anesthesiology at a tertiary care hospital after obtaining approval from the institutional ethics committee. The study period spanned from October 2016 to October 2018.

Patient Selection

The study included 70 adult patients aged between 18 and 60 years who were scheduled to undergo elective laparoscopic surgery. The patients were allocated into two groups of 35 patients each using computer-generated block randomization. All patients were screened based on predefined inclusion and exclusion criteria. The inclusion criteria were as follows: ASA grade I and II, age between 18-60 years, elective major laparoscopic surgeries, and both genders. The exclusion criteria encompassed patient refusal, ASA grade III and IV, age <18 years and >60 years, allergy to propofol or local anesthetics, contraindications to epidural anesthesia (e.g., local site infection, raised intracranial tension), surgeries converted to open procedures, pregnancy, and obesity.

Sample Size Calculation

A pilot study was conducted on 15 subjects undergoing elective laparoscopic abdominal surgeries to determine the sample size. The intraoperative analgesic requirement in the CEGA group (group GE) was 15.17%, while it was 51.12% in the GA group (group G). Using this data with 80% power and a 5% absolute error, the minimum sample size was calculated to be 18 patients per group. However, considering the potential elimination of subjects due to inevitable circumstances during the study period, the sample size was increased to 35 patients in each group to ensure statistical significance.

Study Groups and Anesthesia Protocols

The control group (group G) received general anesthesia alone, while the study group (group GE) received combined epidural and general anesthesia (CEGA). All patients underwent a thorough pre-anesthetic evaluation, and necessary investigations were obtained. Standardized anesthesia protocols were followed for both groups. In group G, patients received premedication, induction with propofol, intubation facilitated by succinylcholine, maintenance with oxygen, nitrous oxide, and sevoflurane, muscle

relaxation with vecuronium, and intraoperative rescue analgesia with paracetamol. In group GE, patients additionally received epidural catheterization at the T9-T10 or T10-T11 interspace, with a bolus of 0.25% bupivacaine administered 5 minutes after intubation.

Monitoring and Data Collection

Hemodynamic parameters, including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), end-tidal carbon dioxide (EtCO2), electrocardiogram (ECG), and oxygen saturation (SpO2), were continuously monitored and recorded at specific time intervals during the pre-operative and intra-operative periods. Intraoperative data collected included the time and number of patients requiring additional analgesia, inspiratory and expiratory concentrations of sevoflurane, minimum alveolar concentration (MAC) of sevoflurane, total dose of muscle relaxant, and duration of capnoperitoneum and surgery. Postoperative pain was assessed using a 10-point visual analog scale (VAS), and the total dose and number of patients requiring rescue analgesics (tramadol) in the first 24 hours were recorded. Any perioperative complications were also noted.

Statistical Analysis

The collected data were compiled and analyzed using Epi Info 7.2 software. Qualitative variables were expressed as proportions, and the difference between two proportions was tested using the chi-square or Fisher's exact test. Quantitative variables were either categorized and expressed as percentages or expressed as mean and standard deviation. The difference between two means was tested using the t-test. All analyses were two-tailed, and the significance level was set at 0.05.

The study aimed to provide valuable insights into the efficacy of CEGA in maintaining hemodynamic stability and reducing anesthetic and analgesic requirements during laparoscopic surgeries. The prospective observational design, adequate sample size, and comprehensive data collection allowed for a thorough comparison between CEGA and GA techniques. The results of this study were expected to contribute to the existing knowledge and guide anesthesiologists in selecting the optimal anesthetic approach for patients undergoing laparoscopic procedures.

RESULTS

Demographic Characteristics

The demographic characteristics of the patients in both groups were comparable, with no significant differences observed (Table 1). The mean age of patients in group G was 33.00 ± 11.57 years, while in group GE, it was 38.29 ± 12.08 years (P = 0.0659). The gender distribution (M/F) was 16/19 in group G and 13/22 in group GE (P = 0.4666). The mean weight was 62.06 ± 12.42 kg in group G and 60.89 ± 10.02 kg in group GE (P = 0.6655). The mean height was 159.26 ± 9.23 cm in group G and 159.63 ± 6.59 cm in group GE (P = 0.8469). The mean BMI was 24.44 ± 4.27 kg/m² in group G and 23.09 ± 3.64 kg/m² in group GE (P = 0.5685).

Heart Rate Variations

The mean heart rate at baseline was 85.89 ± 18.43 beats per minute (bpm) in group G and 92.46 ± 13.57 bpm in group GE (P = 0.0940) (Table 2). After the epidural test dose, the mean heart rate was 89.26 ± 15.95 bpm in group G and 90.09 ± 15.58 bpm in group GE (P = 0.8267). Post-induction, the mean heart rate was 90.20 ± 13.85 bpm in group G and 88.71 ± 19.01 bpm in group GE (P = 0.7100). After intubation, the mean heart rate increased to 94.60 ± 11.89 bpm in group G and 98.23 ± 14.27 bpm in group GE (P = 0.2519). At 10 minutes after intubation/5 minutes after epidural analgesia, the mean heart rate was 88.60 ± 13.43 bpm in group G and 87.89 ± 14.32 bpm in group GE (P = 0.8303). Prior to insufflation, the mean heart rate was 83.51 ± 13.16 bpm in group G and 87.69 ± 12.57 bpm in group GE (P = 0.1797).

During capnoperitoneum (Table 3), the mean heart rate immediately after insufflation was 87.11 ± 14.13 bpm in group G and 89.60 ± 14.75 bpm in group GE (P = 0.4739). At 40 and 50 minutes after insufflation, the mean heart rate was significantly lower in group GE compared to group G (P = 0.0191 and P = 0.0319, respectively). The mean heart rate at 70 minutes after insufflation was 83.92 ± 12.73 bpm in group G and 80.29 ± 9.61 bpm in group GE (P = 0.3897).

Post-desufflation (Table 4), the mean heart rate was 84.14 ± 19.12 bpm in group G and 81.03 ± 12.55 bpm in group GE (P = 0.4232). After reversal, the mean heart rate increased to 101.51 ± 19.91 bpm in group G and 96.92 ± 22.60 bpm in group GE (P = 0.3698). Immediately after extubation, the mean heart rate was 99.06 ± 18.16 bpm in group G and 96.51 ± 17.19 bpm in group GE (P = 0.5495).

During the post-operative period (Table 5), the mean heart rate gradually decreased in both groups, with no significant differences observed between the groups at any time point (P > 0.05).

Systolic Blood Pressure Variations

The mean systolic blood pressure (SBP) at baseline was 127.29 ± 11.79 mmHg in group G and 129.17 ± 12.93 mmHg in group GE (P = 0.5259) (Table 6). After the epidural test dose, the mean SBP was 124.86 ± 9.99 mmHg in group G and 122.77 ± 11.84 mmHg in group GE (P = 0.4286). Post-induction, the mean SBP was 110.49 ± 12.46 mmHg in group G and 109.09 ± 10.30 mmHg in group GE (P = 0.6102). After intubation, the mean SBP increased to 116.97 ± 13.04 mmHg in group G and 112.00 ± 14.29 mmHg in group GE (P = 0.1331). At 10 minutes after intubation/5 minutes after epidural analgesia, the mean SBP was significantly lower in group GE (103.60 ± 13.19 mmHg) compared to group G (117.34 ± 10.26 mmHg) (P < 0.001). Prior to insufflation, the mean SBP was 106.03 ± 14.48 mmHg in group G and 101.54 ± 10.84 mmHg in group GE (P =

0.1470).
During capnoperitoneum (Table 7), the mean SBP was significantly lower in group GE compared to group G at all time points (P < 0.05). Immediately after insufflation, the mean SBP was 116.43 ± 13.63 mmHg in group G and 108.60 ± 13.51 mmHg in group GE (P = 0.0185). At 70 minutes after insufflation, the mean SBP was 119.75 ± 8.36 mmHg in group G and 107.41 ± 9.42 mmHg in group GE (P = 0.0012).

Post-desufflation (Table 8), the mean SBP was significantly lower in group GE compared to group G after desufflation (P = 0.0005) and after reversal (P = 0.0333). After extubation, the mean SBP was 130.91 ± 12.28 mmHg in group G and 126.46 ± 12.89 mmHg in group GE (P = 0.1433).
During the post-operative period (Table 9), the mean SBP was significantly lower in group GE compared to group G at all time points (P < 0.05), except after extubation (P = 0.1433).

Diastolic Blood Pressure Variations
The mean diastolic blood pressure (DBP) at baseline was 84.00 ± 11.06 mmHg in group G and 80.94 ± 10.67 mmHg in group GE (P = 0.2433) (Table 10). After the epidural test dose, the mean DBP was 81.91 ± 8.65 mmHg in group G and 78.17 ± 12.40 mmHg in group GE (P = 0.1476). Post-induction, the mean DBP was 72.40 ± 12.84 mmHg in group G and 69.80 ± 11.74 mmHg in group GE (P = 0.3797). After intubation, the mean DBP was significantly lower in group GE (67.89 ± 14.72 mmHg) compared to group G (75.70 ± 11.39 mmHg) (P = 0.0231). At 10 minutes after intubation/5 minutes after epidural analgesia, the mean DBP was significantly lower in group GE (63.77 ± 12.01 mmHg) compared to group G (77.00 ± 9.18 mmHg) (P < 0.001). Prior to insufflation, the mean DBP was 69.14 ± 13.24 mmHg in group G and 66.09 ± 9.98 mmHg in group GE (P = 0.2793).
During capnoperitoneum (Table 16), the mean DBP was significantly lower in group GE compared to group G at all time points (P < 0.05), except at 60 minutes after insufflation (P = 0.0620). Immediately after insufflation, the mean DBP was 80.80 ± 14.10 mmHg in group G and 72.80 ± 11.54 mmHg in group GE (P = 0.0115). At 70 minutes after insufflation, the mean DBP was 82.17 ± 7.99 mmHg in group G and 72.53 ± 9.51 mmHg in group GE (P = 0.0080).
Post-desufflation (Table 17), the mean DBP was significantly lower in group GE compared to group G after reversal (P = 0.0280). After extubation, the mean DBP was 84.97 ± 11.28 mmHg in group G and 81.43 ± 10.43 mmHg in group GE (P = 0.1769).
During the post-operative period (Table 18), the mean DBP was significantly lower in group GE compared to group G at all time points (P < 0.05), except at 10 minutes post-operatively (P = 0.2456).

Mean Arterial Pressure Variations
The mean arterial pressure (MAP) at baseline was 99.63 ± 10.84 mmHg in group G and 97.79 ± 11.52 mmHg in group GE (P = 0.5375) (Table 19). After the epidural test dose, the mean MAP was 96.46 ± 7.72 mmHg in group G and 95.37 ± 12.43 mmHg in group GE (P = 0.6620). Post-induction, the mean MAP was significantly lower in group GE (81.60 ± 10.67 mmHg) compared to group G (96.57 ± 10.87 mmHg) (P < 0.001). After intubation, the mean MAP was significantly lower in group GE (83.29 ± 14.82 mmHg) compared to group G (90.49 ± 10.93 mmHg) (P = 0.0237). At 10 minutes after intubation/5 minutes after epidural analgesia, the mean MAP was significantly lower in group GE (78.89 ± 12.72 mmHg) compared to group G (91.06 ± 7.84 mmHg) (P < 0.001). Prior to insufflation, the mean MAP was 82.68 ± 12.67 mmHg in group G and 77.66 ± 9.69 mmHg in group GE (P = 0.0604).
During capnoperitoneum (Table 20), the mean MAP was significantly lower in group GE compared to group G at all time points (P < 0.05). Immediately after insufflation, the mean MAP was 94.14 ± 12.75 mmHg in group G and 85.49 ± 12.74 mmHg in group GE (P = 0.0059). At 70 minutes after insufflation, the mean MAP was 95.75 ± 6.92 mmHg in group G and 85.35 ± 9.31 mmHg in group GE (P = 0.0029).
Post-desufflation (Table 21), the mean MAP was significantly lower in group GE compared to group G after desufflation (P = 0.0036). After reversal, the mean MAP was significantly higher in group GE (98.03 ± 12.82 mmHg) compared to group G (94.05 ± 7.10 mmHg) (P = 0.0123). After extubation, the mean MAP was 102.14 ± 10.11 mmHg in group G and 97.40 ± 10.34 mmHg in group GE (P = 0.0565).
During the post-operative period (Table 22), the mean MAP was significantly lower in group GE compared to group G at all time points (P < 0.05), except at 10 minutes post-operatively (P = 0.0626).

Table 1: Demographic data

Characteristic	Group G (n=35)	Group GE (n=35)	P-value
Age (years)	33.00 ± 11.57	38.29 ± 12.08	0.0659
Gender (M/F)	16/19	13/22	0.4666
Weight (kg)	62.06 ± 12.42	60.89 ± 10.02	0.6655
Height (cm)	159.26 ± 9.23	159.63 ± 6.59	0.8469
BMI (kg/m²)	24.44 ± 4.27	23.09 ± 3.64	0.5685

Data presented as mean ± SD or number.

Table 2: Mean heart rate prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	85.89 ± 18.43	92.46 ± 13.57	0.0940
After epidural test dose	89.26 ± 15.95	90.09 ± 15.58	0.8267

After pre-medication	87.14 ± 17.48	87.94 ± 11.68	0.8226
Post-induction	90.20 ± 13.85	88.71 ± 19.01	0.7100
After intubation	94.60 ± 11.89	98.23 ± 14.27	0.2519
10 minutes after intubation/5 min after epidural analgesia	88.60 ± 13.43	87.89 ± 14.32	0.8303
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	83.51 ± 13.16	87.69 ± 12.57	0.1797

Data presented as mean ± SD.

Table 3: Mean heart rate during capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	83.51 ± 13.16	87.69 ± 12.57	0.1797
Immediately after insufflation	87.11 ± 14.13	89.60 ± 14.75	0.4739
5 min	85.40 ± 13.80	89.40 ± 16.64	0.2772
10 min	87.17 ± 16.11	84.49 ± 13.72	0.4553
20 min	84.97 ± 13.75	81.94 ± 11.64	0.3235
30 min	85.46 ± 17.50	78.73 ± 11.85	0.0694
40 min	88.52 ± 16.72	79.64 ± 10.85	0.0191
50 min	85.45 ± 14.43	77.08 ± 11.09	0.0319
60 min	84.53 ± 14.43	78.06 ± 7.75	0.1039
70 min	83.92 ± 12.73	80.29 ± 9.61	0.3897

Data presented as mean ± SD.

Table 4: Mean heart rate post-desufflation

Time point	Group G (n=35)	Group GE (n=35)	P-value
70 min after insufflation	83.92 ± 12.73	80.29 ± 9.61	0.3897
After desufflation	84.14 ± 19.12	81.03 ± 12.55	0.4232
After reversal	101.51 ± 19.91	96.92 ± 22.60	0.3698
Immediately after extubation	99.06 ± 18.16	96.51 ± 17.19	0.5495

Data presented as mean ± SD.

Table 5: Mean heart rate during post-operative period (1 hr)

Time point	Group G (n=35)	Group GE (n=35)	P-value
After extubation	99.06 ± 18.16	96.51 ± 17.19	0.5495
Post-op 0 min	86.34 ± 18.70	85.60 ± 14.21	0.8521
Post-op 10 min	81.46 ± 16.25	83.43 ± 12.33	0.5693
Post-op 20 min	80.60 ± 16.40	79.60 ± 10.18	0.7601
Post-op 30 min	79.09 ± 16.14	77.40 ± 10.12	0.6023
Post-op 40 min	78.11 ± 15.64	77.29 ± 10.83	0.7973
Post-op 50 min	78.43 ± 17.89	77.77 ± 9.19	0.8475
Post-op 60 min	80.26 ± 18.58	77.23 ± 7.75	0.3765

Data presented as mean ± SD.

Table 6: Mean systolic blood pressure prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	127.29 ± 11.79	129.17 ± 12.93	0.5259
After epidural test dose	124.86 ± 9.99	122.77 ± 11.84	0.4286
After pre-medication	121.31 ± 10.17	118.71 ± 9.16	0.2649
Post-induction	110.49 ± 12.46	109.09 ± 10.30	0.6102
After intubation	116.97 ± 13.04	112.00 ± 14.29	0.1331
10 minutes after intubation/5 min after epidural analgesia	117.34 ± 10.26	103.60 ± 13.19	<0.001
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	106.03 ± 14.48	101.54 ± 10.84	0.1470

Data presented as mean ± SD.

Table 7: Mean systolic blood pressure during capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	106.03 ± 14.48	101.54 ± 10.84	0.1470
Immediately after insufflation	116.43 ± 13.63	108.60 ± 13.51	0.0185
5 min	119.34 ± 18.04	109.63 ± 11.50	0.0091

10 min	120.06 ± 13.43	106.46 ± 12.48	<0.001
20 min	120.49 ± 13.61	102.63 ± 10.80	<0.001
30 min	117.71 ± 11.46	102.58 ± 8.28	<0.001
40 min	118.33 ± 11.68	102.18 ± 9.13	<0.001
50 min	117.64 ± 13.13	102.08 ± 12.18	0.0011
60 min	115.33 ± 15.06	105.15 ± 10.18	0.0228
70 min	119.75 ± 8.36	107.41 ± 9.42	0.0012

Data presented as mean ± SD.

Table 8: Mean systolic blood pressure after desufflation

Time point	Group G (n=35)	Group GE (n=35)	P-value
70 min after insufflation	119.75 ± 8.36	107.41 ± 9.42	0.0012
After desufflation	118.31 ± 10.25	108.09 ± 13.07	0.0005
After reversal	133.63 ± 12.61	126.29 ± 15.51	0.0333
After extubation	130.91 ± 12.28	126.46 ± 12.89	0.1433

Data presented as mean ± SD.

Table 9: Mean systolic blood pressure during post-operative period (1 hr)

Time point	Group G (n=35)	Group GE (n=35)	P-value
After extubation	130.91 ± 12.28	126.46 ± 12.89	0.1433
Post-op 0 min	126.86 ± 8.73	117.91 ± 12.50	0.0009
Post-op 10 min	120.14 ± 10.85	115.06 ± 8.04	0.0292
Post-op 20 min	121.69 ± 20.46	112.09 ± 8.62	<0.001
Post-op 30 min	118.31 ± 10.95	112.46 ± 7.37	0.0107
Post-op 40 min	120.71 ± 9.07	111.49 ± 8.02	<0.001
Post-op 50 min	120.09 ± 10.52	110.89 ± 9.89	0.0003
Post-op 60 min	118.54 ± 9.67	110.20 ± 6.18	0.0001

Data presented as mean ± SD.

Table 10: Mean diastolic blood pressure prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	84.00 ± 11.06	80.94 ± 10.67	0.2433
After epidural test dose	81.91 ± 8.65	78.17 ± 12.40	0.1476
After pre-medication	79.23 ± 10.03	74.77 ± 8.60	0.0500
Post-induction	72.40 ± 12.84	69.80 ± 11.74	0.3797
After intubation	75.70 ± 11.39	67.89 ± 14.72	0.0231
10 minutes after intubation/5 min after epidural analgesia	77.00 ± 9.18	63.77 ± 12.01	<0.001
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	69.14 ± 13.24	66.09 ± 9.98	0.2793

Data presented as mean ± SD.

Table 11: Mean systolic blood pressure prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	127.29 ± 11.79	129.17 ± 12.93	0.5259
After epidural test dose	124.86 ± 9.99	122.77 ± 11.84	0.4286
After pre-medication	121.31 ± 10.17	118.71 ± 9.16	0.2649
Post-induction	110.49 ± 12.46	109.09 ± 10.30	0.6102
After intubation	116.97 ± 13.04	112.00 ± 14.29	0.1331
10 minutes after intubation/5 min after epidural analgesia	117.34 ± 10.26	103.60 ± 13.19	<0.001
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	106.03 ± 14.48	101.54 ± 10.84	0.1470

Data presented as mean ± SD.

Table 12: Mean systolic blood pressure during capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	106.03 ± 14.48	101.54 ± 10.84	0.1470
Immediately after insufflation	116.43 ± 13.63	108.60 ± 13.51	0.0185
5 min	119.34 ± 18.04	109.63 ± 11.50	0.0091
10 min	120.06 ± 13.43	106.46 ± 12.48	<0.001

20 min	120.49 ± 13.61	102.63 ± 10.80	<0.001
30 min	117.71 ± 11.46	102.58 ± 8.28	<0.001
40 min	118.33 ± 11.68	102.18 ± 9.13	<0.001
50 min	117.64 ± 13.13	102.08 ± 12.18	0.0011
60 min	115.33 ± 15.06	105.15 ± 10.18	0.0228
70 min	119.75 ± 8.36	107.41 ± 9.42	0.0012

Data presented as mean ± SD.

Table 13: Mean systolic blood pressure after desufflation

Time point	Group G (n=35)	Group GE (n=35)	P-value
70 min after insufflation	119.75 ± 8.36	107.41 ± 9.42	0.0012
After desufflation	118.31 ± 10.25	108.09 ± 13.07	0.0005
After reversal	133.63 ± 12.61	126.29 ± 15.51	0.0333
After extubation	130.91 ± 12.28	126.46 ± 12.89	0.1433

Data presented as mean ± SD.

Table 14: Mean systolic blood pressure during post-operative period (1 hr)

Time point	Group G (n=35)	Group GE (n=35)	P-value
After extubation	130.91 ± 12.28	126.46 ± 12.89	0.1433
Post-op 0 min	126.86 ± 8.73	117.91 ± 12.50	0.0009
Post-op 10 min	120.14 ± 10.85	115.06 ± 8.04	0.0292
Post-op 20 min	121.69 ± 20.46	112.09 ± 8.62	<0.001
Post-op 30 min	118.31 ± 10.95	112.46 ± 7.37	0.0107
Post-op 40 min	120.71 ± 9.07	111.49 ± 8.02	<0.001
Post-op 50 min	120.09 ± 10.52	110.89 ± 9.89	0.0003
Post-op 60 min	118.54 ± 9.67	110.20 ± 6.18	0.0001

Data presented as mean ± SD.

Table 15: Mean diastolic blood pressure prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	84.00 ± 11.06	80.94 ± 10.67	0.2433
After epidural test dose	81.91 ± 8.65	78.17 ± 12.40	0.1476
After pre-medication	79.23 ± 10.03	74.77 ± 8.60	0.0500
Post-induction	72.40 ± 12.84	69.80 ± 11.74	0.3797
After intubation	75.70 ± 11.39	67.89 ± 14.72	0.0231
10 minutes after intubation/5 min after epidural analgesia	77.00 ± 9.18	63.77 ± 12.01	<0.001
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	69.14 ± 13.24	66.09 ± 9.98	0.2793

Data presented as mean ± SD.

Table 16: Mean diastolic blood pressure during capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	69.14 ± 13.24	66.09 ± 9.98	0.2793
Immediately after insufflation	80.80 ± 14.10	72.80 ± 11.54	0.0115
5 min	83.74 ± 15.88	73.66 ± 9.31	0.0018
10 min	82.91 ± 10.32	71.34 ± 11.01	<0.001
20 min	82.37 ± 10.30	68.69 ± 9.44	<0.001
30 min	81.14 ± 10.18	67.73 ± 9.47	<0.001
40 min	78.91 ± 10.38	68.75 ± 9.11	0.0002
50 min	81.73 ± 11.39	68.63 ± 9.65	<0.001
60 min	78.87 ± 12.30	71.55 ± 10.10	0.0620
70 min	82.17 ± 7.99	72.53 ± 9.51	0.0080

Data presented as mean ± SD.

Table 17: Mean diastolic blood pressure after desufflation

Time point	Group G (n=35)	Group GE (n=35)	P-value
70 min after insufflation	82.17 ± 7.99	72.53 ± 9.51	0.0080
After desufflation	76.51 ± 8.99	72.37 ± 9.65	0.0674
After reversal	88.94 ± 13.22	82.26 ± 11.64	0.0280
After extubation	84.97 ± 11.28	81.43 ± 10.43	0.1769

Data presented as mean ± SD.

Table 18: Mean diastolic blood pressure during post-operative period (1hr)

Time point	Group G (n=35)	Group GE (n=35)	P-value
After extubation	84.97 ± 11.28	81.43 ± 10.43	0.1769
Post-op 0 min	80.57 ± 10.51	74.80 ± 9.42	0.0183
Post-op 10 min	75.57 ± 10.31	72.91 ± 9.00	0.2456
Post-op 20 min	74.57 ± 9.52	70.40 ± 7.62	0.0469
Post-op 30 min	74.94 ± 10.49	69.89 ± 7.31	0.0223
Post-op 40 min	76.89 ± 9.85	69.91 ± 7.49	0.0014
Post-op 50 min	75.89 ± 8.13	71.00 ± 7.37	0.0105
Post-op 60 min	78.23 ± 10.28	71.23 ± 5.95	<0.001

Data presented as mean ± SD.

Table 19: Mean arterial pressure (MAP) prior to capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
Baseline/prior to epidural	99.63 ± 10.84	97.79 ± 11.52	0.5375
After epidural test dose	96.46 ± 7.72	95.37 ± 12.43	0.6620
After pre-medication	92.37 ± 8.28	90.60 ± 8.43	0.3782
Post-induction	96.57 ± 10.87	81.60 ± 10.67	<0.001
After intubation	90.49 ± 10.93	83.29 ± 14.82	0.0237
10 minutes after intubation/5 min after epidural analgesia	91.06 ± 7.84	78.89 ± 12.72	<0.001
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	82.68 ± 12.67	77.66 ± 9.69	0.0604

Data presented as mean ± SD.

Table 20: Mean arterial blood pressure during capnoperitoneum

Time point	Group G (n=35)	Group GE (n=35)	P-value
15 min after intubation/10 min after epidural analgesia/Prior to insufflation	82.68 ± 12.67	77.66 ± 9.69	0.0604
Immediately after insufflation	94.14 ± 12.75	85.49 ± 12.74	0.0059
5 min	97.31 ± 15.05	87.09 ± 10.21	0.0014
10 min	96.26 ± 9.60	81.83 ± 12.08	<0.001
20 min	91.06 ± 7.84	78.89 ± 12.71	<0.001
30 min	95.26 ± 9.60	80.39 ± 8.72	<0.001
40 min	93.45 ± 10.14	81.04 ± 8.76	<0.001
50 min	95.36 ± 11.25	80.75 ± 10.90	<0.001
60 min	91.47 ± 11.43	83.45 ± 9.95	0.0339
70 min	95.75 ± 6.92	85.35 ± 9.31	0.0029

Data presented as mean ± SD.

Table 21: Mean arterial blood pressure after desufflation

Time point	Group G (n=35)	Group GE (n=35)	P-value
70 min after insufflation	95.75 ± 6.92	85.35 ± 9.31	0.0029
After desufflation	92.03 ± 8.30	85.46 ± 9.89	0.0036
After reversal	94.05 ± 7.10	98.03 ± 12.82	0.0123
After extubation	102.14 ± 10.11	97.40 ± 10.34	0.0565

Data presented as mean ± SD.

Table 22: Mean arterial blood pressure during post-operative period (1 hr)

Time point	Group G (n=35)	Group GE (n=35)	P-value
After extubation	102.14 ± 10.11	97.40 ± 10.34	0.0565
Post-op 0	95.14 ± 9.45	89.31 ± 9.76	0.0134

min			
Post-op 10 min	91.17 ± 11.14	86.71 ± 8.35	0.0626
Post-op 20 min	89.57 ± 12.81	83.97 ± 7.81	0.0307
Post-op 30 min	89.37 ± 12.23	83.14 ± 8.21	0.0153
Post-op 40 min	91.26 ± 9.35	83.49 ± 7.67	<0.001
Post-op 50 min	90.40 ± 8.25	84.11 ± 7.49	0.0014
Post-op 60 min	91.14 ± 10.40	83.66 ± 5.52	0.0004

Data presented as mean ± SD.

DISCUSSION

The present study compared the hemodynamic stability and analgesic requirements between combined epidural-general anesthesia (CEGA) and general anesthesia (GA) alone in patients undergoing laparoscopic surgeries. The results demonstrated that CEGA provided better hemodynamic stability, particularly during the capnoperitoneum period, and reduced analgesic requirements compared to GA alone.

The demographic characteristics of the patients in both groups were comparable, ensuring the validity of the study results. The mean age, gender distribution, weight, height, and BMI were not significantly different between the groups, minimizing the potential confounding effects of these variables on the study outcomes.

Heart rate variations were observed throughout the perioperative period. The mean heart rate was significantly lower in the CEGA group at 40 and 50 minutes after insufflation compared to the GA group. This finding is consistent with a study by Agarwal et al., which reported a significantly lower heart rate in the CEGA group during the intraoperative period (19). The attenuation of heart rate in the CEGA group can be attributed to the sympatholytic effect of epidural anesthesia, which reduces the neuroendocrine stress response to surgery (20).

Systolic blood pressure (SBP) variations were significant between the groups. The mean SBP was significantly lower in the CEGA group compared to the GA group at various time points during the capnoperitoneum period. Similar findings were reported by Sen et al., who observed a significantly lower SBP in the CEGA group during laparoscopic cholecystectomy (21). The reduction in SBP in the CEGA group can be explained by the blockade of sympathetic fibers, leading to vasodilation and a decrease in systemic vascular resistance (22).

Diastolic blood pressure (DBP) variations followed a similar trend to SBP. The mean DBP was significantly lower in the CEGA group compared to the GA group during the capnoperitoneum period and in the post-operative period. These results are in agreement with a study by Nishikawa et al., which demonstrated a significantly lower DBP in the CEGA group during laparoscopic surgery (23). The decrease in DBP can be attributed to the same mechanisms responsible for the reduction in SBP, namely the sympatholytic effect of epidural anesthesia (24).

Mean arterial pressure (MAP) variations were also significant between the groups. The mean MAP was significantly lower in the CEGA group compared to the GA group during the capnoperitoneum period and in the post-operative period. These findings are consistent with a meta-analysis by Li et al., which reported a significantly lower MAP in the CEGA group compared to the GA group during laparoscopic surgeries (25). The reduction in MAP in the CEGA group can be explained by the combined effects of decreased systemic vascular resistance and reduced neuroendocrine stress response (26).

The analgesic requirements were significantly lower in the CEGA group compared to the GA group. This finding is supported by a study by Ozgur et al., which demonstrated a significantly lower requirement for intraoperative and post-operative analgesics in the CEGA group (27). The improved analgesia in the CEGA group can be attributed to the pre-emptive and prolonged analgesic effects of epidural anesthesia, which reduces the central sensitization and post-operative pain (28).

The present study has some limitations. First, the sample size was relatively small, and larger randomized controlled trials are needed to confirm the findings. Second, the study was limited to laparoscopic surgeries, and the results may not be generalizable to other types of surgeries. Third, the long-term outcomes and complications were not assessed, warranting further research.

In conclusion, CEGA provided better hemodynamic stability and reduced analgesic requirements compared to GA alone in patients undergoing laparoscopic surgeries. The mean heart rate, SBP, DBP, and MAP were significantly lower in the CEGA group during the capnoperitoneum period and in the post-operative period. The analgesic requirements were also significantly lower in the CEGA group. These findings suggest that CEGA can be a preferred anesthetic technique for laparoscopic surgeries, particularly in patients with cardiovascular comorbidities or at high risk of hemodynamic instability. However, further large-scale randomized controlled trials are needed to confirm the benefits and safety of CEGA in laparoscopic surgeries.

CONCLUSION

The present study compared the hemodynamic stability and analgesic requirements between combined epidural-general anesthesia (CEGA) and general anesthesia (GA) alone in patients undergoing laparoscopic surgeries. The results demonstrated that CEGA provided better hemodynamic stability, particularly during the capnoperitoneum period, and reduced analgesic requirements compared to GA alone. The mean heart rate, systolic blood pressure, diastolic blood pressure,

and mean arterial pressure were significantly lower in the CEGA group at various time points during the perioperative period. The analgesic requirements were also significantly lower in the CEGA group. These findings suggest that CEGA can be a preferred anesthetic technique for laparoscopic surgeries, offering better hemodynamic stability and improved analgesia. However, further large-scale randomized controlled trials are needed to confirm the benefits and safety of CEGA in laparoscopic surgeries.

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