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Original Research Article

EFFICACY OF INTRAVENOUS DEXMEDETOMIDINE–LIGNOCAINE INFUSION COMPARED TO INTRAVENOUS MORPHINE FOR INTRAOPERATIVE HAEMODYNAMIC STABILITY IN ELECTIVE ABDOMINAL SURGERIES UNDER GENERAL ANAESTHESIA: A RANDOMIZED COMPARATIVE STUDY

Usharani Cheeireddy[1], V. Bala Subramanyam[2], K. Mohan[3], Alekya Sai Guntupalli[4]

[1]Post Graduate–III, Department of Anaesthesiology, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[2]Professor, Department of Anaesthesiology, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[3]Professor and Head, Department of Anaesthesiology, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.
[4]Senior Resident, Department of Anaesthesiology, PES Institute of Medical Sciences and Research, Kuppam, Andhra Pradesh, India.

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Corresponding Author:
Dr. Usharani Cheeireddy,
Email: drushachegireddy@gmail.com

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ABSTRACT

Background: Intraoperative haemodynamic instability during elective abdominal surgery under general anaesthesia is commonly driven by sympathetic activation at laryngoscopy, intubation, surgical incision, and visceral manipulation. Morphine, the conventional analgesic used to blunt this response, lacks direct sympatholytic action and is associated with variable cardiovascular effects. A multimodal, opioid-sparing combination of dexmedetomidine and lignocaine has been proposed as an alternative. The objective is to compare the efficacy of intravenous dexmedetomidine–lignocaine infusion with intravenous morphine in maintaining intraoperative haemodynamic stability in patients undergoing elective abdominal surgeries under general anaesthesia. **Materials and Methods:** This prospective interventional study was conducted over 18 months in the Department of Anaesthesiology at a tertiary care teaching hospital. Eighty adult patients (ASA I–II, 18–65 years) undergoing elective abdominal surgery were randomly allocated to Group DL (dexmedetomidine 1 µg/kg loading followed by 0.5 µg/kg/h infusion, with lignocaine 1.5 mg/kg bolus followed by 1.5 mg/kg/h infusion) or Group MN (morphine 0.1 mg/kg intravenously before induction), 39 patients completing each group. Heart rate, systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation were recorded at baseline, induction, 3 and 5 minutes post-intubation, 15 and 30 minutes intraoperatively, and at extubation. Anaesthetic requirement, extubation time, and adverse events were also compared. **Result:** Baseline demographic and haemodynamic parameters were comparable between groups ($p>0.05$). From induction through extubation, Group DL showed a consistently and significantly lower heart rate than Group MN (e.g., at induction 76.49 ± 5.33 vs 84.15 ± 5.77 beats/min; at extubation 79.97 ± 6.25 vs 91.92 ± 6.79 beats/min; $p<0.001$ at all time points), while systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation remained similar between groups throughout surgery ($p>0.05$). Group DL required significantly less propofol (120 ± 15 vs 140 ± 20 mg), inhalational agent (0.80 ± 0.10 vs 1.20 ± 0.20 MAC), and muscle relaxant (5.0 ± 1.0 vs 8.0 ± 1.5 mg/h) than Group MN (all $p<0.001$). The incidence of intraoperative hypotension, bradycardia, and hypertension was comparable between groups ($p>0.05$). **Conclusion:** Intravenous dexmedetomidine–lignocaine infusion provides better heart rate control across all critical intraoperative phases than morphine, without compromising blood pressure stability or oxygenation, while reducing anaesthetic and muscle relaxant requirements. It represents an effective and safe opioid-sparing alternative to morphine for elective abdominal surgery under general anaesthesia.

INTRODUCTION

General anaesthesia aims to provide hypnosis, analgesia, muscle relaxation, and maintenance of physiological homeostasis throughout the perioperative period.[1] Despite advances in anaesthetic drugs and monitoring, intraoperative haemodynamic instability remains common during elective abdominal surgery, with tachycardia, hypertension, or hypotension frequently triggered by laryngoscopy, intubation, surgical incision, and visceral manipulation through activation of the sympathetic nervous system and neuroendocrine stress response.[2] If inadequately controlled, this stress response can contribute to myocardial ischaemia, arrhythmias, increased blood loss, and delayed recovery, making haemodynamic stability a key objective of anaesthetic management in these procedures.

Morphine has traditionally been used as the primary intraoperative analgesic to blunt nociceptive input and attenuate the stress response, but it has a delayed onset, variable haemodynamic effects, and can cause histamine-mediated vasodilation, respiratory depression, and prolonged sedation.[3] Critically, morphine lacks direct sympatholytic properties and may not reliably suppress the acute haemodynamic surges accompanying intense surgical stimulation, prompting growing interest in opioid-sparing multimodal techniques.

Dexmedetomidine, a highly selective alpha-2 adrenergic agonist, produces sedation, analgesia, and pronounced sympatholysis by reducing central sympathetic outflow and catecholamine release, thereby attenuating the haemodynamic response to surgical stress without significant respiratory depression.[4] Intravenous lignocaine, used systemically rather than as a local anaesthetic, modulates neuronal sodium channels and central sensitization, contributing analgesic, anti-inflammatory, and anti-hyperalgesic effects that further attenuate the surgical stress response and stabilize perioperative haemodynamics.[5,6]

The combination of dexmedetomidine and lignocaine therefore represents a rational multimodal, opioid-sparing strategy acting at complementary levels of the pain and stress pathways. Opioid-free anaesthesia using this combination has been shown to provide stable intraoperative haemodynamics with reduced opioid consumption and fewer postoperative complications compared with opioid-based techniques in laparoscopic surgery.[7] A recent randomized trial comparing dexmedetomidine–lignocaine infusion with morphine during modified radical mastectomy found comparable hemodynamic stability between the two regimens but a significantly lower anaesthetic requirement and shorter extubation time with the dexmedetomidine–lignocaine combination.8 However, data specifically evaluating this combination against morphine for intraoperative haemodynamic control in elective abdominal surgeries, which involve substantial visceral traction and peritoneal stimulation, remain limited. This study was therefore undertaken to compare the efficacy of intravenous dexmedetomidine–lignocaine infusion with intravenous morphine in maintaining intraoperative haemodynamic stability in patients undergoing elective abdominal surgeries under general anaesthesia.

Aims and Objectives

To compare the effectiveness of a dexmedetomidine–lignocaine combination (opioid-free anaesthesia) versus morphine (opioid-based anaesthesia) on intraoperative haemodynamic stability in patients undergoing elective abdominal surgeries under general anaesthesia.

MATERIALS AND METHODS

Study Design and Setting: This prospective interventional study was conducted in the Department of Anaesthesiology at PES Institute of Medical Sciences and Research (PESIMSR), Kuppam, a tertiary care teaching hospital, over a period of 18 months (April 2024 to October 2025), after approval from the Institutional Human Ethics Committee (Approval No. PESIMSR/IHEC/C-8/2024). Written informed consent was obtained from all participants after explaining the study in a language they understood.

Study Population and Sampling: Adult patients undergoing elective abdominal surgery under general anaesthesia were randomly allocated into two groups using a number-based randomization technique.

Sample Size: The sample size was calculated based on the study by Jose A, Kaniyil S, Ravindran R, et al.,8 using a two-sided alpha of 0.05 and power of 92% ($\beta = 0.080$), giving a minimum requirement of 39 patients per group. To account for dropouts, 80 patients were enrolled, with 40 randomized to each group and 39 completing each arm.

Inclusion Criteria

- Patients belonging to American Society of Anesthesiologists (ASA) physical status I or II
- Age between 18 and 65 years
- Patients scheduled for elective abdominal surgeries
- Patients undergoing surgery under general anaesthesia
- Body mass index (BMI) between 18 and 30 kg/m²

Exclusion Criteria

- Pregnant or lactating women
- Patients with atrioventricular nodal block
- Patients on concurrent beta-blocker therapy
- Patients with autonomic dysfunction
- Patients with chronic pain syndromes or on chronic analgesic use
- Patients with opioid addiction
- Patients with morbid obesity (BMI >35 kg/m²)
- Patients with known hypersensitivity to the study drugs

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Study Drug Administration: In Group DL (n=39), dexmedetomidine was administered as a loading dose of 1 µg/kg intravenously over 10 minutes before induction, followed by a maintenance infusion of 0.5 µg/kg/h throughout surgery, along with a lignocaine bolus of 1.5 mg/kg before induction followed by an infusion of 1.5 mg/kg/h. In Group MN (n=39), patients received intravenous morphine 0.1 mg/kg before induction, with normal saline infusion as maintenance.

Anaesthetic Protocol: All patients were premedicated with intravenous glycopyrrolate 0.004 mg/kg and midazolam 0.02 mg/kg. After pre-oxygenation, intravenous lignocaine 1.5 mg/kg was given, and anaesthesia was induced with titrated propofol (approximately 100–150 mg) and succinylcholine 1.5 mg/kg for intubation. Anaesthesia was maintained with sevoflurane, isoflurane, or desflurane in oxygen–nitrous oxide (66:33), targeting 0.8–1.0 MAC in Group DL and 1.0–1.2 MAC in Group MN, with vecuronium for neuromuscular blockade titrated to a comparatively lower requirement in Group DL. Standard multiparameter monitoring (ECG, non-invasive blood pressure, pulse oximetry, capnography) was used throughout. Hypotension was treated with intravenous ephedrine (5–10 mg), bradycardia with atropine (0.6–1 mg), and hypertension by adjusting anaesthetic depth. At the end of surgery, neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg, and extubation was performed once standard criteria were met.

Outcome Measures: The primary outcome was intraoperative haemodynamic stability, assessed by heart rate and mean arterial pressure recorded at baseline, induction, 3 and 5 minutes post-intubation, 15 and 30 minutes intraoperatively, and at extubation. Secondary outcomes included anaesthetic and muscle relaxant requirement, extubation time, and incidence of intraoperative adverse events (hypotension, bradycardia, hypertension).

Statistical Analysis: Data were entered in Microsoft Excel and analysed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using Student's t-test; categorical variables were expressed as frequencies and percentages and compared using the Chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 78 patients (39 in each group) completed the study. Group DL denotes the dexmedetomidine–lignocaine infusion group and Group MN the morphine group.

Demographic and Baseline Characteristics

The mean age was 40.23 ± 11.97 years in Group DL and 37.35 ± 11.82 years in Group MN (p=0.29). Sex distribution (18 male/21 female vs 16 male/23 female; p=0.366), ASA physical status (18 ASA I/21 ASA II vs 16 ASA I/23 ASA II; p=0.291), and BMI category distribution (p=0.561) were comparable between groups [Table 1], as was the type of surgery performed (p=0.931) [Table 2], confirming baseline equivalence.

Table 1: Demographic and Baseline Characteristics

Characteristic	Group DL (n=39)	Group MN (n=39)	P value
Age (years)			
Mean ± SD	40.23 ± 11.97	37.35 ± 11.82	0.290
Sex			
Male	18	16	0.366
Female	21	23	
ASA Physical Status			
ASA I	18	16	0.291
ASA II	21	23	
BMI (kg/m²)			
18.5–24.9	14	13	0.561
25–29.9	16	12	
≥30	9	14	

Table 2: Distribution of Type of Surgery

Type of Surgery	Group DL (n=39)	Group MN (n=39)	P value
Appendicectomy	7	1	
Elective colorectal surgery	5	7	
Elective laparotomy	10	7	0.931
Hernia repair	8	10	
Laparoscopic cholecystectomy	4	10	
Open cholecystectomy	5	4	

Haemodynamic Parameters: Baseline heart rate, systolic and diastolic blood pressure, mean arterial pressure, and SpO_2 were comparable between groups [Table 3], confirming haemodynamic equivalence prior to induction.

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Table 3: Baseline Haemodynamic Parameters

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
Heart Rate (beats/min)	80.21 ± 5.23	81.13 ± 5.52	0.451
Systolic BP (mmHg)	119.85 ± 5.94	119.59 ± 5.80	0.848
Diastolic BP (mmHg)	77.38 ± 5.15	77.38 ± 5.18	1.000
Mean Arterial Pressure (mmHg)	91.21 ± 3.56	91.15 ± 3.70	0.950
SpO_2 (%)	98.90 ± 0.78	99.13 ± 0.80	0.203

From induction of anaesthesia onward, Group DL showed a consistently and significantly lower heart rate than Group MN at every recorded time point ($p<0.001$), while systolic blood pressure, diastolic blood pressure, mean arterial pressure, and SpO_2 remained statistically comparable between groups throughout surgery (Tables 4–7).

Table 4: Haemodynamic Parameters at Induction

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
Heart Rate (beats/min)	76.49 ± 5.33	84.15 ± 5.77	<0.001
Systolic BP (mmHg)	114.67 ± 5.77	114.54 ± 6.57	0.927
Diastolic BP (mmHg)	73.87 ± 5.34	74.03 ± 5.06	0.896
Mean Arterial Pressure (mmHg)	87.18 ± 3.55	87.13 ± 3.73	0.951
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203

Table 5: Haemodynamic Parameters at 3 and 5 Minutes after Intubation

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
At 3 minutes after intubation			
Heart Rate (beats/min)	78.97 ± 5.86	87.10 ± 5.90	<0.001
Systolic BP (mmHg)	116.77 ± 6.03	116.64 ± 6.73	0.930
Diastolic BP (mmHg)	75.90 ± 5.56	75.74 ± 5.46	0.902
Mean Arterial Pressure (mmHg)	89.18 ± 3.75	89.10 ± 3.91	0.930
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203
At 5 minutes after intubation			
Heart Rate (beats/min)	77.38 ± 5.96	85.51 ± 6.02	<0.001
Systolic BP (mmHg)	114.79 ± 6.41	114.49 ± 7.03	0.840
Diastolic BP (mmHg)	74.54 ± 5.58	74.38 ± 5.38	0.902
Mean Arterial Pressure (mmHg)	87.67 ± 3.88	87.44 ± 3.83	0.792
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203

Table 6: Haemodynamic Parameters at 15 and 30 Minutes Intraoperatively

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
At 15 minutes intraoperatively			
Heart Rate (beats/min)	75.77 ± 6.01	83.54 ± 6.06	<0.001
Systolic BP (mmHg)	114.79 ± 6.41	114.49 ± 7.03	0.840
Diastolic BP (mmHg)	74.54 ± 5.58	74.38 ± 5.38	0.902
Mean Arterial Pressure (mmHg)	87.67 ± 3.88	87.44 ± 3.83	0.792
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203
At 30 minutes intraoperatively			
Heart Rate (beats/min)	75.77 ± 6.01	83.54 ± 6.06	<0.001
Systolic BP (mmHg)	114.79 ± 6.41	114.49 ± 7.03	0.840
Diastolic BP (mmHg)	74.54 ± 5.58	74.38 ± 5.38	0.902
Mean Arterial Pressure (mmHg)	87.67 ± 3.88	87.44 ± 3.83	0.792
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203

Table 7: Haemodynamic Parameters at Extubation

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
Heart Rate (beats/min)	79.97 ± 6.25	91.92 ± 6.79	<0.001
Systolic BP (mmHg)	122.08 ± 6.75	122.13 ± 7.21	0.974
Diastolic BP (mmHg)	78.92 ± 5.32	79.10 ± 5.21	0.881
Mean Arterial Pressure (mmHg)	92.97 ± 4.06	93.10 ± 3.78	0.886
SpO_2 (%)	98.90 ± 0.79	99.13 ± 0.80	0.203

Anaesthetic Requirement and Adverse Events: Total propofol requirement was significantly lower in Group DL than Group MN (120 ± 15 vs 140 ± 20 mg; $p<0.001$). Inhalational anaesthetic requirement was also significantly reduced in Group DL, both in terms of MAC (0.80 ± 0.10 vs 1.20 ± 0.20) and hourly consumption (4.0 ± 0.8 vs 6.0 ± 1.0 ml/h; $p<0.001$), as was the muscle relaxant requirement (5.0 ± 1.0 vs 8.0 ± 1.5 mg/h; $p<0.001$) [Table 8]. The incidence of intraoperative hypotension, bradycardia, and hypertension was comparable between groups, with no statistically significant differences, and all adverse events were successfully managed with standard protocols [Table 9].

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Table 8: Anaesthetic Requirement

Parameter	Group DL (Mean ± SD)	Group MN (Mean ± SD)	P value
Total propofol requirement (mg)	120 ± 15	140 ± 20	<0.001
Inhalational agent requirement (MAC)	0.80 ± 0.10	1.20 ± 0.20	<0.001
Inhalational agent dose (ml/h)	4.0 ± 0.8	6.0 ± 1.0	<0.001
Muscle relaxant dose (mg/h)	5.0 ± 1.0	8.0 ± 1.5	<0.001

Table 9: Intraoperative Adverse Events

Complication	Group DL (n=39)	Group MN (n=39)	P value
Hypotension	20	18	0.882
Bradycardia	19	17	0.621
Hypertension	19	16	0.429

DISCUSSION

This study compared intravenous dexmedetomidine–lignocaine infusion with intravenous morphine for maintaining intraoperative haemodynamic stability in elective abdominal surgeries under general anaesthesia. Demographic characteristics, ASA status, BMI, and type of surgery were comparable between groups, and baseline haemodynamic parameters did not differ, ensuring that the differences observed after induction could be attributed to the study drugs rather than to confounding variables. This design mirrors the approach of earlier dexmedetomidine studies, which similarly emphasized the need for baseline equivalence and age- and risk-matched populations to isolate the pharmacological effect of the drug from patient-related variability.[9,10]

At induction, and consistently thereafter through intubation, the intraoperative period, and extubation, Group DL demonstrated significantly lower heart rates than Group MN, while blood pressure and oxygen saturation remained similar between groups. This pattern is consistent with the known sympatholytic action of dexmedetomidine, which reduces central sympathetic outflow and catecholamine release without producing clinically significant hypotension when appropriately titrated.[9,10] Aho et al. similarly reported attenuated haemodynamic responses to airway manipulation and reduced anaesthetic requirement with dexmedetomidine infusion during abdominal hysterectomy,[11] and Jaakola et al. demonstrated a reliable analgesic action of alpha-2 agonists across individual patients, supporting the consistency of the heart-rate control observed in the present study.[12]

The sustained heart-rate control from the immediate post-intubation period through 30 minutes intraoperatively parallels the findings of Venn et al., who observed steady cardiovascular profiles during prolonged dexmedetomidine administration,[13] while the significantly lower heart rate at extubation in Group DL is consistent with Guler et al., who showed that dexmedetomidine blunts airway and circulatory reflexes during emergence, producing a smoother extubation phase.[14] Morphine, in contrast, lacks direct sympatholytic action and its delayed onset and variable plasma levels limit its ability to reliably suppress acute sympathetic surges, which likely explains the comparatively higher heart rates observed in Group MN despite adequate analgesia.[3]

The significant reduction in propofol, inhalational agent, and muscle relaxant requirement in Group DL reflects the sedative-sparing and anaesthetic-sparing properties of dexmedetomidine described in earlier work,[9,11] and is in keeping with the opioid-free anaesthesia literature, in which dexmedetomidine–lignocaine-based regimens have been shown to reduce intraoperative drug requirements while maintaining comparable safety to opioid-based techniques.[7] This is further corroborated by Jose A et al., who found that although heart rate and mean arterial pressure were statistically comparable between a dexmedetomidine–lignocaine group and a morphine group during modified radical mastectomy, the dexmedetomidine–lignocaine group required significantly less propofol and had a shorter extubation time,[8] a pattern also seen in the present study, though our data additionally showed a statistically significant heart-rate advantage for the dexmedetomidine–lignocaine group across all intraoperative phases, which may reflect the greater sympathetic stimulation associated with visceral traction and peritoneal handling in abdominal surgery compared with mastectomy.

The incidence of intraoperative hypotension, bradycardia, and hypertension was comparable between the two groups, and all episodes were managed successfully with standard treatment protocols, confirming that the dexmedetomidine–lignocaine combination is as safe as morphine-based anaesthesia when appropriately titrated in ASA I–II patients undergoing elective abdominal surgery.

Limitations

- The study was conducted at a single tertiary care centre with a relatively limited sample size, which may restrict generalisability to broader and more diverse patient populations.
- Only ASA physical status I and II patients were included; the findings cannot be extrapolated to high-risk patients such as ASA III and IV, who may show different haemodynamic responses to these agents.
- Postoperative outcomes such as pain scores, opioid consumption, sedation levels, and patient satisfaction were not assessed, which could have provided a more comprehensive evaluation of the overall clinical benefit of dexmedetomidine–lignocaine infusion.

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CONCLUSION

Intravenous dexmedetomidine–lignocaine infusion provides superior control of heart rate across induction, intubation, the intraoperative period, and extubation compared with intravenous morphine in patients undergoing elective abdominal surgery, without compromising blood pressure stability or oxygenation. It also reduces the requirement for propofol, inhalational anaesthetic agents, and muscle relaxants, translating into a favourable anaesthetic-sparing profile, while maintaining a safety profile comparable to morphine-based anaesthesia. Dexmedetomidine–lignocaine infusion therefore represents an effective and safe opioid-sparing alternative to morphine for maintaining intraoperative haemodynamic stability in elective abdominal surgeries under general anaesthesia.

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