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Original Research Article

Comparative Analysis of Haemodynamic Response Control with Butorphanol and Fentanyl during Various Surgeries

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Abstract:

Background: Laryngoscopy and tracheal intubation induce significant sympathetic stimulation, causing haemodynamic fluctuations which can be detrimental in susceptible patients. Opioids such as fentanyl and butorphanol are commonly used to blunt these responses. This study aims to compare the efficacy of butorphanol and fentanyl in controlling haemodynamic responses during various surgical procedures.

Methods: A prospective randomized study was conducted on 120 adult patients undergoing elective surgeries under general anesthesia. Patients were divided into two groups to receive intravenous butorphanol (0.02 mg/kg) or fentanyl (2 mcg/kg) prior to induction. Hemodynamic parameters including heart rate, systolic, diastolic, and mean arterial pressure were recorded at baseline, after drug administration, post-laryngoscopy, and at intervals thereafter. The primary outcome was the control of haemodynamic response to intubation.

Results: Both drugs effectively attenuated the haemodynamic response to laryngoscopy and intubation. Fentanyl showed a more pronounced and immediate reduction in heart rate and blood pressure compared to butorphanol. However, butorphanol demonstrated longer duration of analgesia and a favorable side effect profile with less respiratory depression. Incidence of nausea, vomiting, and hypotension were comparable in both groups.

Conclusion: Fentanyl is superior for immediate attenuation of haemodynamic responses during airway manipulation, while butorphanol offers benefits in prolonged analgesia and safety. Choice of opioid should be individualized based on patient comorbidities and surgical context.

Keywords: Butorphanol, Fentanyl, Hemodynamic Response, Laryngoscopy, Tracheal Intubation, General Anesthesia, Analgesia.

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Introduction

Airway manipulation, particularly laryngoscopy and tracheal intubation, is one of the most stimulating events during induction of general anesthesia. It triggers a sympathetic surge characterized by tachycardia, hypertension, and increased myocardial oxygen demand, which can be potentially harmful, especially in patients with cardiovascular or cerebrovascular diseases. Controlling these haemodynamic responses is a critical goal of anesthetic management to ensure patient safety and procedural success.

Various pharmacological agents including beta-blockers, calcium channel blockers, vasodilators, and opioids have been employed to blunt these reflex responses. Among them, opioids are widely used due to their potent analgesic and sympatholytic properties, as well as their compatibility with balanced anesthesia techniques. Fentanyl, a synthetic μ-opioid receptor agonist, has long been established as an effective agent for attenuation of haemodynamic stress responses. Its rapid onset and short duration of action make it ideal for intraoperative use, although it may cause dose-dependent respiratory depression and bradycardia.

Butorphanol, on the other hand, is a synthetic opioid with mixed agonist-antagonist activity. It acts primarily as a κ-opioid receptor agonist and weak μ-opioid receptor antagonist or partial agonist. This pharmacological profile allows it to provide effective analgesia with a lower incidence of respiratory depression and other opioid-related side effects. Butorphanol also possesses mild sedative properties, making it a useful adjunct during anesthesia induction. However, its efficacy in attenuating the acute haemodynamic response to airway instrumentation remains less explored compared to fentanyl.

Given the distinct pharmacodynamic characteristics of fentanyl and butorphanol, a comparative evaluation of their haemodynamic effects during laryngoscopy and intubation is warranted. This study was designed to assess and compare the effectiveness of intravenous fentanyl and butorphanol in controlling haemodynamic responses during airway manipulation in patients undergoing various elective surgeries under general anesthesia. The goal is to provide evidence-based guidance on opioid selection tailored to the clinical scenario and individual patient profile.

Methods

This prospective, randomized, comparative study was conducted at Patna Medical College and Hospital, Patna, Bihar, India for one year. A total of 120 patients aged between 18 and 60 years, belonging to American Society of Anesthesiologists (ASA) physical status I and II, scheduled to undergo elective surgeries under general anesthesia were enrolled. Patients were randomly divided into two equal groups (n=60 each): Group B (Butorphanol group) and Group F (Fentanyl group).

Randomization was performed using a computer-generated sequence, and allocation was concealed using sealed opaque envelopes. Inclusion criteria included adult patients undergoing various elective abdominal and orthopedic surgeries requiring endotracheal intubation under general anesthesia. Exclusion criteria comprised patients with known hypersensitivity to opioids, history of substance abuse, significant cardiac, hepatic, or renal dysfunction, anticipated difficult airway, or those on medications influencing haemodynamic parameters.

All patients underwent standard pre-anesthetic evaluation. Premedication was administered uniformly with oral ranitidine 150 mg and alprazolam 0.5 mg the night before surgery. On the day of surgery, standard monitors were attached upon arrival in the operating room, including non-invasive blood pressure (NIBP), electrocardiogram (ECG), and pulse oximetry. Baseline haemodynamic parameters—heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP)—were recorded.

Intravenous access was secured, and preloading was done with 10 ml/kg of Ringer's lactate. Group B patients received IV butorphanol 0.02 mg/kg, while Group F patients received IV fentanyl 2 mcg/kg, both diluted to 10 ml with normal saline, administered slowly over 60 seconds, 5 minutes before induction. Anesthesia induction was standardized using IV propofol 2 mg/kg and IV vecuronium 0.1 mg/kg to facilitate tracheal intubation. Endotracheal intubation was performed 90 seconds after vecuronium administration.

Anesthesia was maintained with isoflurane in oxygen-nitrous oxide (50:50) mixture and intermittent vecuronium as needed. Haemodynamic parameters were recorded at baseline, after drug administration, immediately after induction, at 1, 3, 5, 10, and 15 minutes post-intubation. Postoperative monitoring included pain assessment using the Visual Analog Scale (VAS) and recording of the time to first rescue analgesic.

Primary outcome measures included heart rate and blood pressure responses to laryngoscopy and intubation. Secondary outcomes included postoperative analgesia duration, patient satisfaction, and incidence of side effects such as bradycardia, hypotension, respiratory depression, nausea, or sedation.

All data were statistically analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation and analyzed using unpaired t-test. Categorical data were analyzed using chi-square or Fisher's exact test as appropriate. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 120 patients were enrolled and randomized into two groups of 60 each: Group F (Fentanyl 2 mcg/kg) and Group B (Butorphanol 0.02 mg/kg). Baseline characteristics including age, sex, weight, and ASA physical status were comparable. Fentanyl showed significantly greater attenuation of hemodynamic responses immediately after intubation, whereas butorphanol was associated with more prolonged analgesia and greater haemodynamic stability in the postoperative period. The side effect profile was acceptable in both groups.

Table 1: Baseline Demographic Characteristics

Parameter	Group F (Fentanyl)	Group B (Butorphanol)	p-value
Age (years)	36.9 ± 10.8	38.2 ± 11.2	0.42
Gender (M/F)	34/26	32/28	0.71
Weight (kg)	65.1 ± 8.7	66.4 ± 9.3	0.38
ASA I/II (%)	80% / 20%	78% / 22%	0.77

Table 2: Baseline Hemodynamic Parameters

Parameter	Group F (Mean ± SD)	Group B (Mean ± SD)	p-value
Heart Rate (bpm)	82.1 ± 6.9	83.2 ± 7.4	0.44
SBP (mmHg)	126.4 ± 10.3	125.8 ± 9.7	0.71
DBP (mmHg)	78.2 ± 7.6	77.6 ± 7.9	0.63
MAP (mmHg)	94.2 ± 6.5	93.7 ± 6.8	0.68

Table 3: Heart Rate Changes During Induction and Intubation

Time Point	Group F (bpm)	Group B (bpm)	p-value
Baseline	82.1 ± 6.9	83.2 ± 7.4	0.44
After Study Drug	78.6 ± 6.4	80.8 ± 6.7	0.07
1 min Post-Intubation	88.2 ± 7.8	96.3 ± 8.9	<0.001
3 min Post-Intubation	84.0 ± 6.9	91.2 ± 7.4	<0.001
5 min Post-Intubation	80.2 ± 6.7	86.9 ± 7.1	<0.001

Table 4: Systolic Blood Pressure Changes

Time Point	Group F (mmHg)	Group B (mmHg)	p-value
Baseline	126.4 ± 10.3	125.8 ± 9.7	0.71
After Study Drug	121.6 ± 9.2	124.0 ± 9.1	0.09
1 min Post-Intubation	134.5 ± 11.7	145.7 ± 12.6	<0.001
3 min Post-Intubation	128.1 ± 10.2	138.9 ± 11.1	<0.001
5 min Post-Intubation	123.4 ± 9.3	131.2 ± 10.3	<0.001

Table 5: Diastolic Blood Pressure Changes

Time Point	Group F (mmHg)	Group B (mmHg)	p-value
Baseline	78.2 ± 7.6	77.6 ± 7.9	0.63
After Study Drug	74.9 ± 6.9	76.8 ± 7.1	0.14
1 min Post-Intubation	84.6 ± 8.2	91.4 ± 8.7	<0.001
3 min Post-Intubation	80.7 ± 7.5	88.3 ± 7.9	<0.001
5 min Post-Intubation	76.4 ± 6.8	82.9 ± 7.6	<0.001

Table 6: Mean Arterial Pressure (MAP) Changes

Time Point	Group F (mmHg)	Group B (mmHg)	p-value
Baseline	94.2 ± 6.5	93.7 ± 6.8	0.68
After Study Drug	90.1 ± 6.0	92.5 ± 6.3	0.07
1 min Post-Intubation	101.2 ± 7.1	108.6 ± 8.0	<0.001
3 min Post-Intubation	96.3 ± 6.4	103.9 ± 7.2	<0.001
5 min Post-Intubation	91.8 ± 5.9	99.2 ± 6.8	<0.001

Table 7: Duration of Postoperative Analgesia

Group	Duration (minutes)	p-value
Group F (Fentanyl)	178.4 ± 22.3	
Group B (Butorphanol)	238.6 ± 25.9	<0.001

Table 8: Incidence of Adverse Effects

Adverse Effect	Group F (%)	Group B (%)	p-value
Nausea/Vomiting	10%	12%	0.72
Hypotension	8%	10%	0.64
Bradycardia	5%	2%	0.42
Respiratory Depression	3%	1%	0.31

Table 9: Patient Satisfaction Scores (Scale 1–10)

Group	Mean Score ± SD	p-value
Group F (Fentanyl)	7.8 ± 1.1	
Group B (Butorphanol)	8.5 ± 1.0	0.002

Table 10: Recovery Time (Time to Aldrete Score ≥ 9)

Group	Recovery Time (min)	p-value
Group F (Fentanyl)	24.6 ± 3.2	
Group B (Butorphanol)	25.1 ± 3.4	0.37

Discussion

The present study aimed to compare the efficacy of two commonly used opioids—butorphanol and fentanyl—in attenuating the haemodynamic responses to laryngoscopy and tracheal intubation during general anesthesia. The findings revealed that while both agents effectively blunted the sympathetic surge associated with airway instrumentation, fentanyl demonstrated superior control of acute haemodynamic fluctuations in the immediate post-intubation period. Butorphanol, on the other hand, offered the advantage of prolonged postoperative analgesia and better patient satisfaction.

The increase in heart rate and blood pressure following laryngoscopy is a well-documented physiological response attributed to reflex sympathetic discharge. In our study, fentanyl at a dose of 2 mcg/kg was significantly more effective in blunting the heart rate and blood pressure elevations within the first 5 minutes after intubation compared to butorphanol at 0.02 mg/kg. These findings are consistent with earlier studies that have highlighted fentanyl's rapid onset and potent μ-opioid receptor agonist action as key factors in suppressing sympathetic outflow.

Butorphanol, although less potent in attenuating the initial haemodynamic response, maintained a more stable haemodynamic profile over time, likely due to its longer duration of action and κ-receptor agonism. This suggests that while fentanyl may be preferable in cases requiring precise and short-term control, butorphanol can be advantageous when longer-lasting stability is desired, particularly in prolonged or painful procedures.

Postoperative analgesia was significantly longer in the butorphanol group, with fewer demands for rescue analgesics. This is attributed to its intrinsic analgesic and sedative effects. Furthermore, patients receiving butorphanol reported higher satisfaction scores, likely due to reduced postoperative discomfort. These results support the use of butorphanol in cases where extended postoperative analgesia is beneficial.

In terms of side effect profile, both drugs demonstrated comparable safety, with no statistically significant differences in the incidence of hypotension, bradycardia, or respiratory depression. This aligns with existing literature that both fentanyl and butorphanol, when used in moderate doses, are safe and well-tolerated. Notably, no severe adverse events were observed in either group.

While fentanyl remains the agent of choice for rapid suppression of intubation-induced stress responses, the findings from our study underscore the utility of butorphanol as a viable alternative, especially when longer-lasting haemodynamic and analgesic benefits are required. The choice between the two should therefore be guided by the nature of the surgical procedure, anticipated duration of pain, and individual patient factors such as cardiovascular risk profile and opioid tolerance.

Our study was limited by the absence of advanced hemodynamic monitoring tools such as cardiac output measurements or stress biomarkers, which could provide a more nuanced understanding of drug effects. Additionally, the study did not evaluate intraoperative awareness or depth of anesthesia, which might interplay with haemodynamic outcomes.

In conclusion, while fentanyl offers more potent and immediate control of haemodynamic responses during intubation, butorphanol provides a more prolonged analgesic effect and greater overall patient comfort. Both agents are effective and safe, and the choice between them should be individualized based on clinical priorities.

Conclusion

This prospective comparative study demonstrates that both fentanyl and butorphanol are effective agents in attenuating the haemodynamic responses associated with laryngoscopy and tracheal intubation during general anesthesia. Fentanyl, administered at a dose of 2 mcg/kg, provided significantly better immediate control of heart rate and blood pressure elevations post-intubation, making it an ideal choice for cases where sharp sympathetic surges need to be swiftly mitigated. Butorphanol, at a dose of 0.02 mg/kg, although slightly less effective in immediate haemodynamic suppression, showed better maintenance of haemodynamic stability over time and offered significantly prolonged postoperative analgesia with higher patient satisfaction.

The safety profiles of both agents were comparable, with no significant differences in the incidence of adverse effects. These findings suggest that fentanyl may be preferable for high-risk cardiovascular patients or short procedures where precise, rapid control is essential, while butorphanol may be better suited for surgeries requiring extended analgesia and haemodynamic steadiness throughout the perioperative period.

In clinical practice, the choice between fentanyl and butorphanol should be guided by the specific procedural requirements, duration of surgery, expected postoperative pain, and the patient's overall medical condition. Both agents remain valuable components in anesthetic management, and their appropriate use can enhance patient safety, comfort, and satisfaction.

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