

Comparative Evaluation of Fentanyl versus Remifentanyl for Attenuation of Hemodynamic Response to Laryngoscopy and Intubation in Adult Patients Undergoing Elective Laparoscopic Surgery: A Prospective, Randomized, Double-Blind Controlled Trial

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Abstract

Background and Aims: Laryngoscopy and tracheal intubation provoke a transient sympathetic surge that can compromise hemodynamic stability even in healthy adults. Fentanyl and remifentanyl are both used to blunt this response but differ in pharmacokinetics. We compared their efficacy and safety in adults undergoing elective laparoscopic surgery.

Methods: In this prospective, randomized, double-blind, controlled trial, 60 ASA I–II adults aged 18–60 years posted for elective laparoscopic surgery were allocated to receive either intravenous fentanyl 2 µg/kg (Group A, n=30) or a remifentanyl infusion 0.1 µg/kg/min (Group B, n=30) before induction. Heart rate (HR), systolic (SBP) and diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded at baseline, 3 minutes post-drug, and 1, 3, 5 and 10 minutes post-intubation. Adverse effects and postoperative rescue analgesic requirement were recorded.

Results: The two groups were comparable for age, sex and ASA status ($p>0.05$). Three minutes after drug administration, HR, DBP and MAP were significantly lower in Group A than Group B ($p=0.0001$, 0.0199 and 0.0082 respectively). At 1 minute post-intubation, Group A showed a significantly higher rise from baseline in HR, SBP, DBP and MAP than Group B (all $p<0.05$). No significant between-group differences persisted from 3 minutes post-intubation onward.

Bradycardia (13.3% vs 6.7%) and hypotension (10.0% vs 3.3%) were more frequent with fentanyl, while postoperative rescue analgesia was required more often after remifentanyl (23.3% vs 3.3%).

Conclusion: Remifentanyl provided better hemodynamic stability than fentanyl in the immediate peri-intubation period and had a more favourable adverse-effect profile, but its rapid offset increased the need for postoperative rescue analgesia. Drug choice should be individualized to clinical priority — hemodynamic control versus sustained analgesia.

Keywords: Fentanyl; Remifentanyl; Laryngoscopy; Tracheal Intubation; Hemodynamic Response; Laparoscopic Surgery.

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Introduction

Laryngoscopy and endotracheal intubation are among the most stimulating events of general anaesthesia, provoking a transient but pronounced sympathetic discharge.[1,2] This response — tachycardia, hypertension and increased myocardial oxygen demand — can be poorly tolerated in patients with compromised cardiovascular reserve, and even in ASA I–II adults it may transiently destabilize intraoperative haemodynamics.[3,4] Opioids are commonly used at induction to blunt

this pressor response.[6] Fentanyl, a lipophilic phenylpiperidine μ -agonist, has a rapid onset but a context-sensitive half-time that lengthens with prolonged administration, which can delay emergence.[9-11] Remifentanyl, an esterase-metabolized opioid, has an ultra-short and context-insensitive half-time of 3–5 minutes, making it attractive for precise titration during short procedures, though its rapid offset predisposes to acute tolerance or hyperalgesia if postoperative

analgesia is not planned.[12-15] Existing trials comparing the two drugs for attenuation of the intubation response have produced mixed results, with some favouring remifentanyl and others finding no difference or even favouring fentanyl, depending on dose, timing and population studied.[24-30] We therefore designed a randomized, double-blind trial to directly compare fentanyl and remifentanyl for haemodynamic control during laryngoscopy and intubation, and for recovery and analgesic outcomes, in adults undergoing elective laparoscopic surgery.

Aims and Objectives

To compare fentanyl and remifentanyl for (i) attenuation of the pressor response to laryngoscopy and intubation, (ii) maintenance of intraoperative haemodynamic stability, and (iii) incidence of adverse effects and postoperative analgesic requirement.

Materials and Methods

This prospective, randomized, double-blind, controlled trial was conducted in the Department of Anaesthesiology, Central Hospital, South Eastern Railway, Kolkata, over 10 months (July 2025–April 2026), after approval by the Institutional Ethics Committee (Memo No. G/39/DNB/E.C., dated 8 May 2025) and written informed consent from all participants. Sixty adults aged 18–60 years, ASA physical status I or II, scheduled for elective laparoscopic surgery, were enrolled. Patients with opioid allergy, BMI >35, or on beta-blockers, and those of ASA III–V, were excluded. Patients were randomized 1:1 using a computer-generated table with allocation concealed in sealed opaque envelopes.

Group A received IV fentanyl 2 µg/kg over 30 seconds, 5 minutes before laryngoscopy, with a concurrent saline infusion to preserve blinding. Group B received a remifentanyl infusion (0.1 µg/kg/min) started 5 minutes before laryngoscopy and continued for 10 minutes post-intubation, with

a concurrent saline bolus. All patients were induced with propofol 2 mg/kg and atracurium 0.5 mg/kg. The anaesthesiologist performing laryngoscopy and the observer recording vital signs were blinded to group allocation.

HR, SBP, DBP and MAP were recorded at baseline, 3 minutes post-drug administration, and 1, 3, 5 and 10 minutes post-intubation. Bradycardia was treated with IV atropine 0.6 mg and hypotension with titrated noradrenaline infusion. All patients received paracetamol 1 g IV and tramadol 50 mg IV after extubation; additional rescue analgesia (fentanyl 1 µg/kg IV) was given for inadequate analgesia.

Sample size was calculated to detect a minimum clinically significant MAP difference of 10 mmHg (SD 12 mmHg) between groups, with 95% confidence and 80% power, yielding 30 patients per group. Data were analysed in R version 4.4.3. Normally distributed continuous variables (confirmed by Shapiro-Wilk test) were compared using the independent-samples t-test; categorical variables were compared using the chi-square or Fisher's exact test; within-group changes over time were analysed by repeated-measures ANOVA. $p < 0.05$ was considered significant.

Results

The two groups were comparable for sex distribution ($p = 0.796$), mean age (44.3 ± 7.3 vs 40.6 ± 7.4 years, $p = 0.056$) and ASA classification ($p = 0.640$). The distribution of surgery types did not differ significantly between groups.

Baseline haemodynamic parameters were similar between groups. Three minutes after drug administration, Group A showed significantly greater reductions in HR, DBP and MAP than Group B (Table 1). At 1 minute post-intubation, all four parameters rose significantly more from baseline in Group A than in Group B. From 3 minutes post-intubation onward, no statistically significant between-group differences remained.

Table 1: Comparison of mean heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure between Group A (fentanyl) and Group B (remifentanyl) at selected time points.

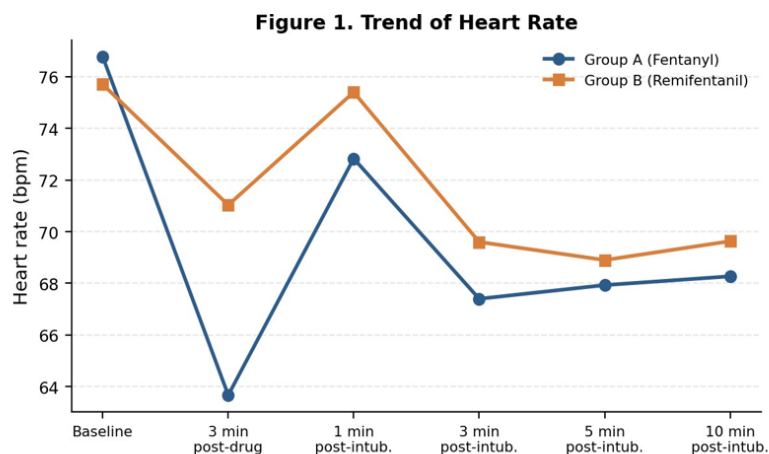
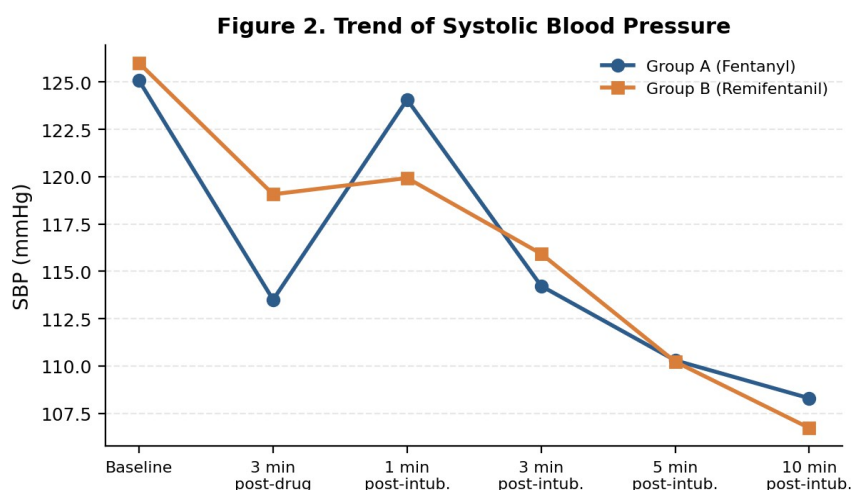
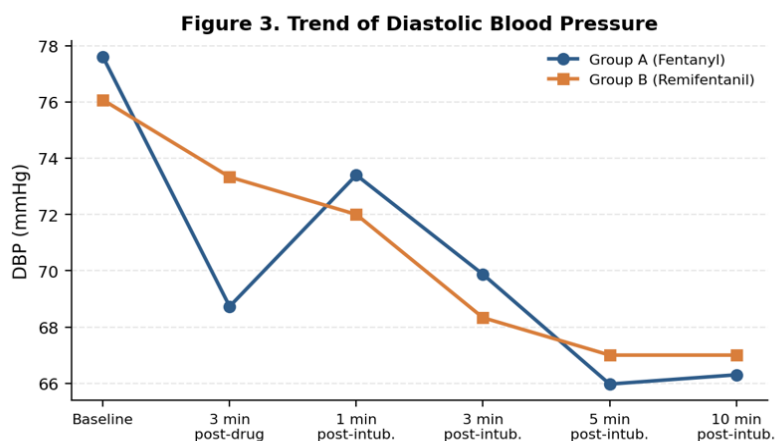
Time point / Parameter	Group A – Fentanyl (mean ± SD)	Group B – Remifentanyl (mean ± SD)
Baseline HR (bpm)	76.77 ± 9.25	75.70 ± 8.29
3 min post-drug HR (bpm)*	63.67 ± 6.04	71.03 ± 7.16
1 min post-intubation SBP (mmHg)*	124.07 ± 8.93	119.93 ± 2.92
10 min post-intubation MAP (mmHg)	79.97 ± 3.57	79.93 ± 3.60

*Statistically significant, $p < 0.05$.

Adverse effects and rescue analgesic use are summarized in Table 2. Bradycardia and hypotension were more frequent in the fentanyl group, whereas rescue analgesia was required more often in the remifentanyl group, reflecting its shorter duration of action.

Table 2: Comparison of adverse effects (bradycardia, hypotension) and postoperative rescue analgesic requirement between the two groups

Adverse event / outcome	Group A (n=30)	Group B (n=30)	Odds ratio
Bradycardia	4 (13.3%)	2 (6.7%)	2.15
Hypotension	3 (10.0%)	1 (3.3%)	3.22
Rescue analgesia required	1 (3.3%)	7 (23.3%)	2.74

**Figure 1: Trend of mean heart rate from baseline to 10 minutes post-intubation in the two groups****Figure 2: Trend of mean systolic blood pressure from baseline to 10 minutes post-intubation in the two groups.****Figure 3: Trend of mean diastolic blood pressure from baseline to 10 minutes post-intubation in the two groups**

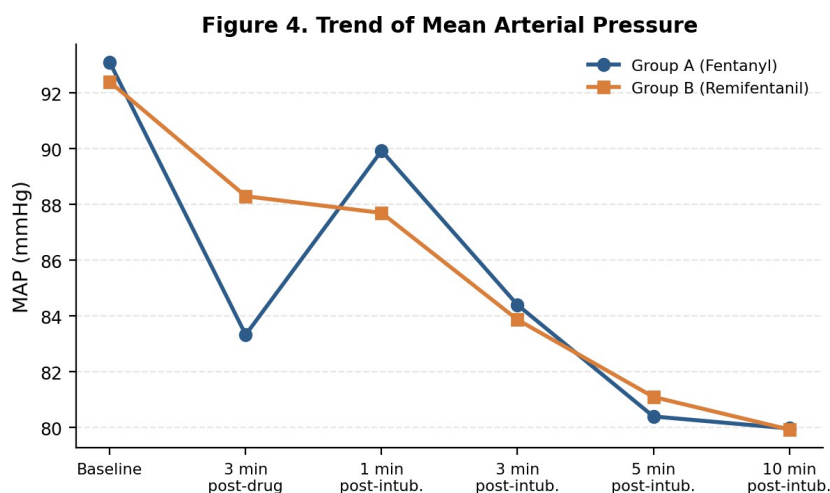


Figure 4: Trend of mean arterial pressure from baseline to 10 minutes post-intubation in the two groups.

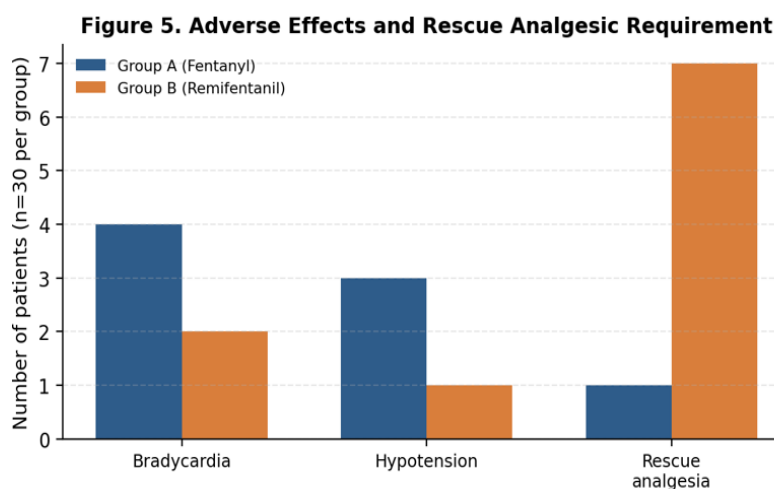


Figure 5: Comparison of adverse effects (bradycardia, hypotension) and postoperative rescue analgesic requirement between the two groups

Discussion

In this randomized, double-blind trial, remifentanyl produced significantly better attenuation of the haemodynamic surge associated with laryngoscopy and intubation than fentanyl, both immediately after drug administration and in the first minute after intubation. This is consistent with Son et al. and Ko et al., who found remifentanyl superior for haemodynamic control at

induction,[25,26] though it contrasts with Kim et al., who found no significant difference between the two drugs,[28] and with Mireskandari et al., who found fentanyl superior to remifentanyl in children.[27] These discrepancies likely reflect differences in dosing regimen, timing of administration relative to laryngoscopy, and patient population.

Beyond 3 minutes post-intubation, the between-group difference in haemodynamic parameters was no longer significant, suggesting that both drugs achieve comparable steady-state control once the initial stimulus has passed. Fentanyl was associated

with a higher incidence of bradycardia and hypotension, consistent with its established side-effect profile at induction doses.[10] Conversely, more patients in the remifentanyl group required postoperative rescue analgesia, in keeping with its ultra-short context-sensitive half-time and known propensity for rapid offset of analgesia unless supplemented pre-emptively.[15,37]

This study has limitations: it was a single-centre trial with a modest sample size, restricted to laparoscopic procedures, which limits generalizability. Larger multicentre trials are warranted to confirm these findings across surgical settings.

Conclusion

Remifentanyl provided superior haemodynamic stability during the immediate peri-intubation period compared with fentanyl, with a more favourable cardiovascular side-effect profile, but at the cost of a higher requirement for postoperative rescue analgesia due to its rapid offset. The choice between the two agents should be guided by

clinical priority: haemodynamic precision favours remifentanyl, while sustained postoperative analgesia favours fentanyl, provided adequate multimodal analgesia is planned in either case.

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References

1. Kovac AL. Controlling the hemodynamic response to laryngoscopy and endotracheal intubation. *J Clin Anesth*. 1996;8(1):63–79.
2. Kayhan Z, Aldemir D, Metler H, Ogus E. Which is responsible for the haemodynamic response due to laryngoscopy and intubation? Catecholamines, vasopressin or angiotensin? *Eur J Anaesthesiol*. 2005;22:780-5.
3. Stoelting RK. Circulatory changes during direct laryngoscopy and tracheal intubation. *Anesthesiology*. 1977;47:381.
4. Morin AM, Gelbner G, Schwarz U, Kahl M, Adams HA, Hulf H, et al. Factors influencing pre-operative stress responses in coronary artery bypass graft patients. *BMC Anaesthesiol*. 2004.
5. Prys-Roberts C, Greene LT, Meloche R, Foëx P. Studies of anaesthesia in relation to hypertension II. *Br J Anaesth*. 1971;43(6):531-547.
6. Teong CY, Huang CC, Sun FJ. The haemodynamic response to endotracheal intubation at different time of fentanyl given during induction. *Sci Rep*. 2020;10:8829.
7. Vardanyan RS, Hruby VJ. Fentanyl-related compounds and derivatives. *Future Med Chem*. 2014;6(4):385-412.
8. Schwartz RB, McCollum D. Pharmacologic adjuncts to intubation. In: Roberts and Hedges' *Clinical Procedures in Emergency Medicine and Acute Care*. 7th ed. Philadelphia: Elsevier; 2019.
9. Klausner JM, Caspi J, Lelcuk S, et al. Delayed muscular rigidity and respiratory depression following fentanyl anesthesia. *Arch Surg*. 1988;123(1):66-7.
10. Glass PS, Gan TJ, Howell S. A review of the pharmacokinetics and pharmacodynamics of remifentanyl. *Anesthesiology*. 1999;90(3):865-873.
11. Michelsen LG, Hug CC Jr. The pharmacokinetics of remifentanyl. *Anesth Analg*. 1996;82(2 Suppl):S4-S10.
12. Gesztesi Z, Mootz BL, White PF. The use of a remifentanyl infusion for hemodynamic control during intracranial surgery. *Anesth Analg*. 1999;89(5):1282-7.
13. Santonocito C, Noto A, Crimi C, Sanfilippo F. Remifentanyl-induced postoperative hyperalgesia. *Local Reg Anesth*. 2018;11:15-23.
14. Jalal SJ, Khudadad AM. Effect of remifentanyl bolus vs fentanyl in attenuating hemodynamic response in videolaryngoscopic endotracheal intubation. *J Sulaimani Med Coll*. 2025;13(2):107-115.
15. Son HW, Lee JM, Park SH, Lee YJ, Oh JM, Hwang SK. Fentanyl versus remifentanyl for cough suppression and recovery after video-assisted thoracic surgery. *J Chest Surg*. 2021;54:200-205.
16. Ko BJ, Oh JN, Lee JH, Choi SR, Lee SC, Chung CJ. Comparison of effects of fentanyl and remifentanyl on hemodynamic response to endotracheal intubation and myoclonus in elderly patients with etomidate induction. *Korean J Anesthesiol*. 2013;64(1):12-8.
17. Mireskandari SM, Abulahrar N, Darabi ME, et al. Comparison of the effect of fentanyl, sufentanyl, alfentanyl and remifentanyl on cardiovascular response to tracheal intubation in children. *Iran J Pediatr*. 2011;21(2):173-180.
18. Kim HT, Kim CK, Lee JH, Kwon YE, Lee JW, Kim DC. Effects of fentanyl and remifentanyl on hemodynamic responses to endotracheal intubation during induction of anesthesia with propofol. *Korean J Anesthesiol*. 2006;51:552-7.
19. Maltepe F, Kocaayan E, Ugurlu BS, Akdeniz B, Guneri S. Comparison of remifentanyl and fentanyl in anaesthesia for elective cardioversion. *Anaesth Intensive Care*. 2006;34(3):353-7.
20. López-Escobar M, León MD, Rey RM, Calderón E, Torres LM. Remifentanyl vs fentanyl in elective surgery: a comparison of four methods. *Eur J Anaesthesiol*. 2000;17:192.
21. Patel SS, Spencer CM. Remifentanyl. *Drugs*. 1996;52(3):417-27.