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Research Article

COMPARATIVE STUDY OF PROPOFOL-REMIFENTANIL VERSUS PROPOFOL-DEXMEDETOMIDINE BASED TOTAL INTRAVENOUS ANESTHESIA IN SURGERIES NOT REQUIRING MUSCLE RELAXANT IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Total Intravenous Anesthesia (TIVA) has become a preferred technique in surgeries not requiring muscle relaxants, as it offers better control of anesthetic depth and minimizes postoperative complications. Propofol is commonly used for TIVA, but its lack of analgesic properties necessitates the use of adjuvants like remifentanil or dexmedetomidine. This study compares the effects of Propofol–Remifentanil (PR) and Propofol–Dexmedetomidine (PD) regimens in elective surgeries without muscle relaxants.

Objective: To evaluate and compare the hemodynamic stability, recovery times, adverse events, and postoperative outcomes between Propofol-Remifentanil and Propofol-Dexmedetomidine based TIVA in patients undergoing elective surgeries not requiring muscle relaxants.

Methods: A prospective, randomized, double-blinded clinical trial was conducted at Silchar Medical College and Hospital over six months. The study involved 80 adult patients, who were randomly assigned to one of two groups: PR (Propofol + Remifentanil) and PD (Propofol + Dexmedetomidine). Various parameters such as heart rate, mean arterial pressure, recovery times, adverse events (hypotension, bradycardia, PONV), propofol consumption, and patient satisfaction were recorded and analyzed.

Results: Group PD demonstrated significantly lower intraoperative heart rates, better hemodynamic control, and reduced postoperative nausea and vomiting (PONV). Group PR had faster recovery times in terms of eye opening and verbal response but required more postoperative analgesics. Dexmedetomidine also reduced total Propofol consumption compared to Remifentanil. Both groups showed similar surgeon satisfaction, with PD being favored for its superior hemodynamic stability.

Conclusion: Dexmedetomidine-based TIVA offers better intraoperative stability and postoperative outcomes compared to Remifentanil-based TIVA in surgeries not requiring muscle relaxants. However, Remifentanil allows for quicker emergence from anesthesia. The choice of adjuvant should depend on specific surgical needs and recovery priorities.

Keywords: *Total Intravenous Anesthesia, Propofol, Remifentanil, Dexmedetomidine, and Postoperative Recovery.*

INTRODUCTION

Total Intravenous Anesthesia (TIVA) has increasingly become a preferred anesthetic technique, especially in surgeries where the use of muscle relaxants is either contraindicated or not necessary. It allows better control of anesthetic depth, reduces environmental contamination, and minimizes postoperative complications like nausea and vomiting. Propofol, a fast-acting hypnotic agent, is widely used in TIVA due to its rapid onset and smooth recovery profile. However, because Propofol lacks intrinsic analgesic properties, adjuvants such as Remifentanil or Dexmedetomidine are often employed to provide balanced anesthesia.

Remifentanil is an ultra-short-acting synthetic opioid, well-suited for TIVA because of its predictable pharmacokinetics and rapid recovery profile. It allows precise titration and helps maintain hemodynamic stability during surgical stimulation. Its major limitation is the potential for postoperative hyperalgesia and increased requirement for rescue analgesics [1]. In contrast, Dexmedetomidine, a selective α2-adrenergic agonist, provides sedation, analgesia, and anxiolysis without significant respiratory depression. Its use as a Propofol adjuvant has shown benefits such as reduced opioid consumption, better postoperative pain control, and decreased incidence of postoperative nausea and vomiting (PONV) [2].

Recent studies have directly compared these two agents as adjuncts in Propofol-based TIVA regimens. For example, in a study involving laparoscopic gynecological surgeries, Dexmedetomidine resulted in significantly better postoperative pain relief and reduced PONV compared to Remifentanil [2]. Similarly, in spinal surgeries, Dexmedetomidine showed superior efficacy in pain management and reduced patient-controlled analgesia (PCA) requirements up to 48 hours postoperatively [3]. These findings support the role of Dexmedetomidine in enhancing the quality of recovery following TIVA.

In surgical scenarios where muscle relaxation is not required—such as neurosurgical, head and neck, or specific ENT procedures—maintaining sufficient anesthetic depth and patient immobility becomes particularly important. In such cases, Dexmedetomidine has been shown to provide stable anesthesia and effective sedation. A comparative study found that both Dexmedetomidine and Propofol were equally effective in maintaining anesthetic depth without long-acting muscle relaxants, as measured by intraoperative movement and hemodynamic changes [4].

Furthermore, Propofol-Remifentanil TIVA has been successfully used without supplemental neuromuscular blockers in laparoscopic pelvic surgeries, demonstrating that muscle relaxants may not always be necessary for adequate surgical conditions [5]. This adds to the growing body of evidence supporting the use of adjuvant-based TIVA techniques in diverse surgical settings.

When evaluating the emergence and recovery profiles of both regimens, Remifentanil allows for faster extubation but often necessitates higher postoperative analgesic doses. On the other hand, Dexmedetomidine has been associated with smoother emergence and lower analgesic demands, despite slightly longer extubation times [6]. These characteristics may be especially valuable in outpatient or short-stay procedures where minimizing PONV and enhancing postoperative comfort are crucial.

Studies have also demonstrated that Dexmedetomidine helps reduce intraoperative Propofol consumption, potentially minimizing the side effects of higher anesthetic doses. In a controlled trial, patients who received Dexmedetomidine required significantly lower total doses of Propofol and showed better surgical field quality in spine surgeries [7]. These benefits are particularly relevant in surgeries that require neuromonitoring or precise motor assessments where clear surgical fields and minimal physiological interference are vital.

In the Indian healthcare context, resource optimization and efficient recovery play a crucial role. A randomized Indian study comparing Propofol and Dexmedetomidine infusions for surgeries not requiring muscle relaxants found both to be safe and effective. However, the Dexmedetomidine group had significantly shorter extubation times and better postoperative hemodynamic stability, underscoring its clinical utility in high-volume tertiary care settings [8].

Additionally, Dexmedetomidine has shown beneficial effects in high-risk cases, such as patients undergoing neurosurgery or emergency procedures. A recent study reported that Propofol-Dexmedetomidine combinations resulted in reduced intraoperative opioid use and better hemodynamic stability, making it a viable choice for critical or high-risk patient populations [9].

A study on pediatric patients undergoing non-relaxant anesthesia protocols found that adding Dexmedetomidine to a Propofol-Remifentanil induction improved intubating conditions and reduced the hemodynamic response to laryngoscopy—again reinforcing its versatility and safety in diverse populations [10].

While both Remifentanil and Dexmedetomidine are effective adjuvants to propofol in TIVA, growing evidence favors Dexmedetomidine for its added benefits in postoperative pain control, opioid-sparing effects, and reduced incidence of

PONV, especially in surgeries not requiring muscle relaxants. This comparative study aims to evaluate these two regimens in a tertiary care setting in India to inform safer, more efficient anesthetic practices.

METHODOLOGY

1. Study Design:
This was a prospective, randomized, double-blinded clinical trial comparing the effects of Propofol–Remifentanil and Propofol–Dexmedetomidine TIVA protocols on hemodynamics, recovery, and adverse events in adults undergoing elective surgeries without muscle relaxants.

2. Study Setting:
The study was conducted in the operating theatres of Silchar Medical College and Hospital, Silchar, Assam, with standard anesthesia monitoring and postoperative observation facilities.

3. Study Duration:
The study was carried out over six months, from January to June 2024, including patient recruitment, anesthesia administration, data collection, and analysis.

4. Participants – Inclusion/Exclusion Criteria:
Inclusion: Adults aged 18–60, ASA I–II, elective surgery (30–60 min), and consented.
Exclusion: Pregnancy, major organ dysfunction, allergy to drugs, BMI >35, emergency surgery, or chronic sedative/opioid use.

5. Study Sampling:
Eligible patients were selected consecutively and randomized using a computer-generated sequence with sealed envelopes to ensure unbiased group allocation.

6. Study Sample Size:
The study included 80 patients, 40 in each group, based on power analysis to detect significant differences in hemodynamic and recovery outcomes.

7. Study Groups:
Group PR received Propofol with Remifentanil; Group PD received Propofol with Dexmedetomidine. Both groups followed identical protocols except for the adjuvant drug.

8. Study Parameters:
Parameters recorded included heart rate, mean arterial pressure, recovery times (eye opening, verbal response, Aldrete score), and adverse events like hypotension, bradycardia, and PONV.

9. Study Procedure:
After Proper Optimization and Pre-Anaesthetic Checkup, the patient is brought into the operation theatre for the procedure after the consent form is documented. The patient is then connected to all the standard monitors. Two large bore 18G iv cannula is secured and then connected to iv fluids and 2 syringe infusion pumps loaded with Propofol and Dexmedetomidine/Remifentanil. After baseline monitoring, the patient is premedicated with Inj. Pantoprazole 40mg iv, Inj. Ondansetron 4mg iv, Inj. Glycopyrrolate 0.2mg iv 15-30 minutes before surgery. Pre-emptive Analgesia provided with Inj. Paracetamol 15 mg/kg iv. The patient was then pre-oxygenated with 100% Oxygen for 3 mins. Then the patients were induced and maintained on TIVA per group protocol as follows:

PD Group:

	LOADING DOSE	**MAINTENANCE DOSE**
DEXMEDETOMIDINE	**0.5-1 mcg/kg iv over 10 mins**	**0.2-0.7 mcg/kg/hour iv (Titrated as per patient responsiveness and vitals)**

	INDUCTION DOSE	**MAINTENANCE DOSE**
PROPOFOL	**0.5-1 mg/kg iv slowly**	**25-75 mcg/kg/min iv (Titrated as per patient responsiveness and vitals)**

PR Group:

	INDUCTION DOSE	**MAINTENANCE DOSE (Titrated as per patient responsiveness and vitals)**
PROPOFOL	**0.5-1 mg/kg iv slowly**	**25-75 mcg/kg/min iv**
REMIFENTANIL	**0.5-1 mcg/kg iv over 30-60 seconds**	**0.025- 0.05 mcg/kg/min iv**

No muscle relaxants were used. Recovery was observed until Aldrete score ≥9.

10. Study Data Collection:
Data were recorded by blinded observers using structured sheets. Intraoperative vitals, recovery times, and complications were documented and later digitized for analysis.

11. Data Analysis:
Data were analyzed using SPSS v25. T-tests and Chi-square tests compared continuous and categorical variables, with $p < 0.05$ considered significant.

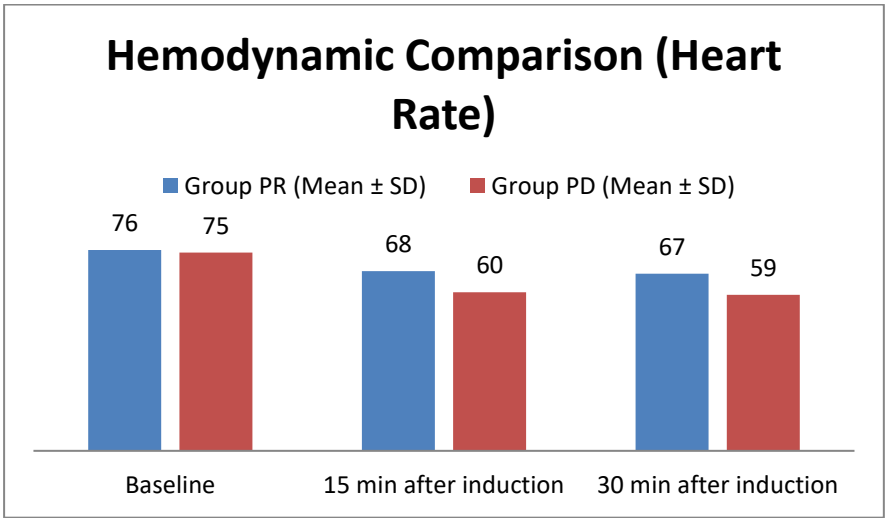
12. Ethical Considerations:
Institutional ethical approval was obtained. Written informed consent was taken. Patient confidentiality was maintained, and participation was voluntary at all stages.

RESULTS

1. Hemodynamic Comparison (Heart Rate)
Group PD showed significantly lower intraoperative heart rate than Group PR, indicating better sympatholytic control with Dexmedetomidine. This difference was statistically significant ($p < 0.01$) (Table 1).

Table 1: Intraoperative Heart Rate (beats per minute)

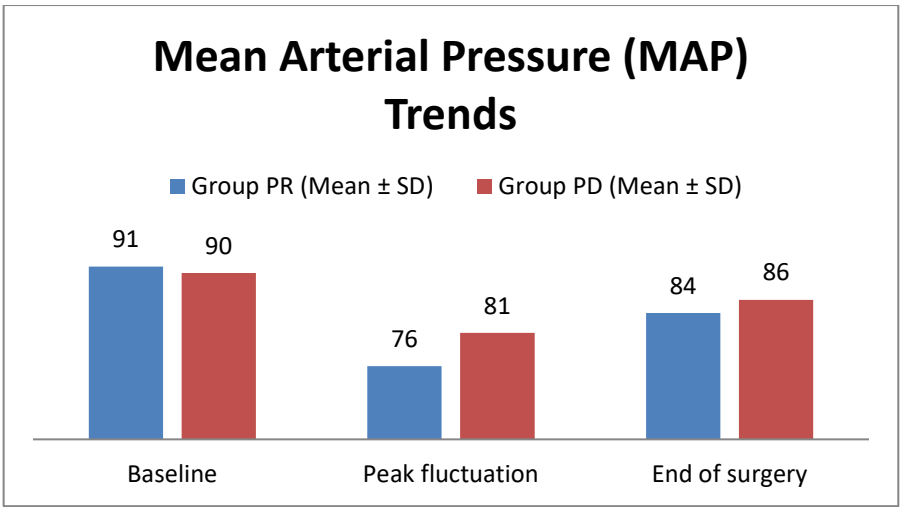
Time Point	Group PR (Mean ± SD)	Group PD (Mean ± SD)	p-value
Baseline	76 ± 9	75 ± 10	0.60
15 min after induction	68 ± 10	60 ± 8	<0.01*
30 min after induction	67 ± 9	59 ± 7	<0.01*



2. Mean Arterial Pressure (MAP) Trends
Group PD maintained more stable MAP throughout the procedure compared to PR, suggesting better intraoperative hemodynamic control (Table 2).

Table 2: Mean Arterial Pressure (mmHg)

Time Point	Group PR (Mean ± SD)	Group PD (Mean ± SD)	p-value
Baseline	91 ± 6	90 ± 5	0.47
Peak fluctuation	76 ± 8	81 ± 7	0.02*
End of surgery	84 ± 6	86 ± 5	0.15

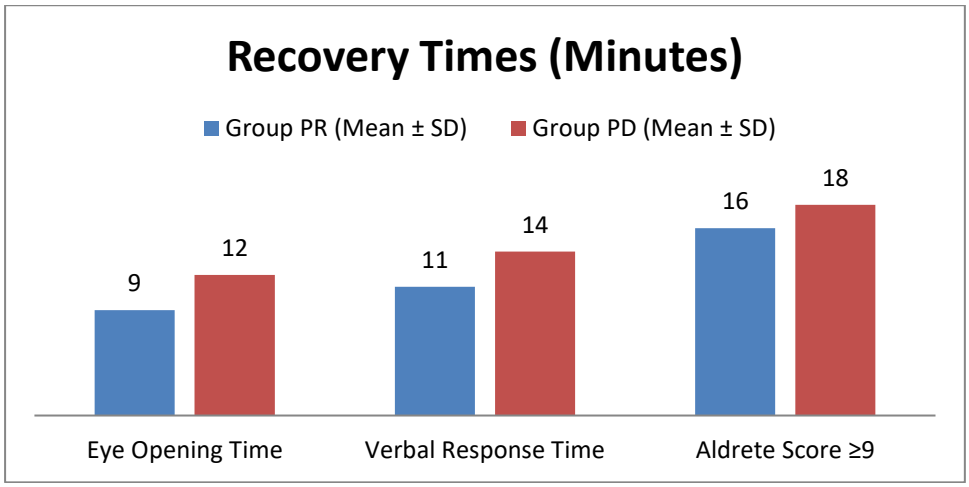


3. Recovery Times

Recovery was faster in Group PR, with shorter eye opening and verbal response times. However, both groups had clinically acceptable recovery durations (Table 3).

Table 3: Recovery Times (Minutes)

Recovery Parameter	Group PR (Mean ± SD)	Group PD (Mean ± SD)	p-value
Eye Opening Time	9 ± 3	12 ± 4	0.03*
Verbal Response Time	11 ± 4	14 ± 5	0.04*
Aldrete Score ≥9	16 ± 5	18 ± 6	0.08

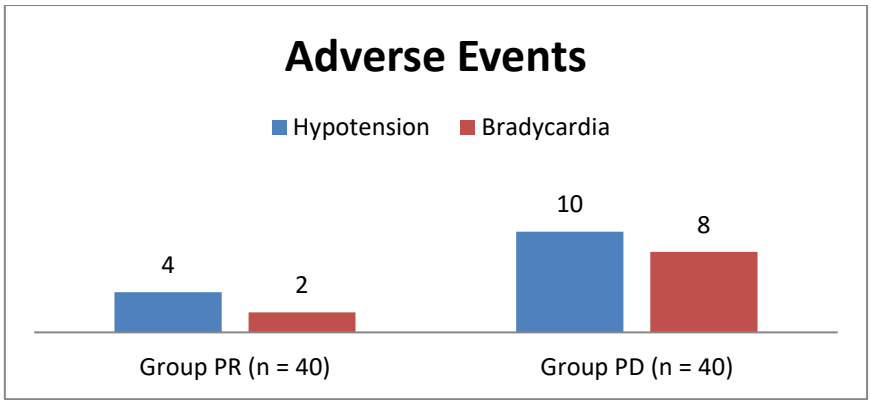


4. Adverse Events – Hypotension and Bradycardia

Group PD had a higher incidence of hypotension and bradycardia, attributed to the α2-agonist effect of dexmedetomidine (Table 4).

Table 4: Adverse Events (n, %)

Adverse Event	Group PR (n = 40)	Group PD (n = 40)	p-value
Hypotension	4 (10%)	10 (25%)	0.04*
Bradycardia	2 (5%)	8 (20%)	0.03*

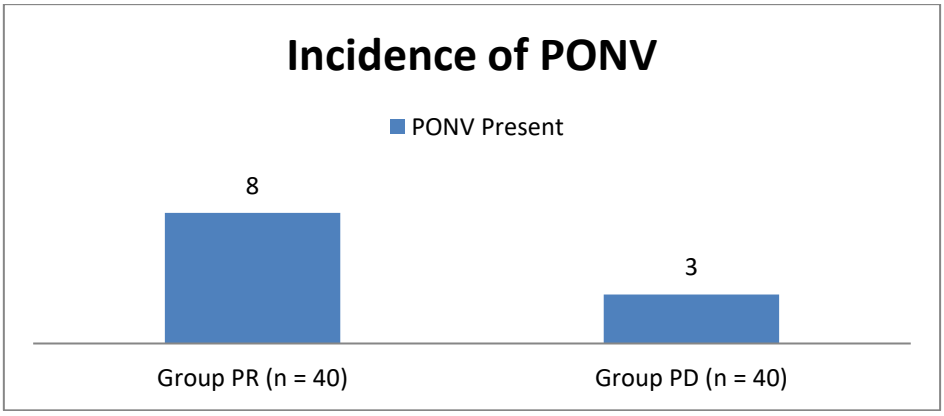


5. Postoperative Nausea and Vomiting (PONV)

PONV was more frequent in Group PR, consistent with opioid-related side effects, while Group PD had lower incidence (Table 5).

Table 5: Incidence of PONV

Outcome	Group PR (n = 40)	Group PD (n = 40)	p-value
PONV Present	8 (20%)	3 (8%)	0.05*

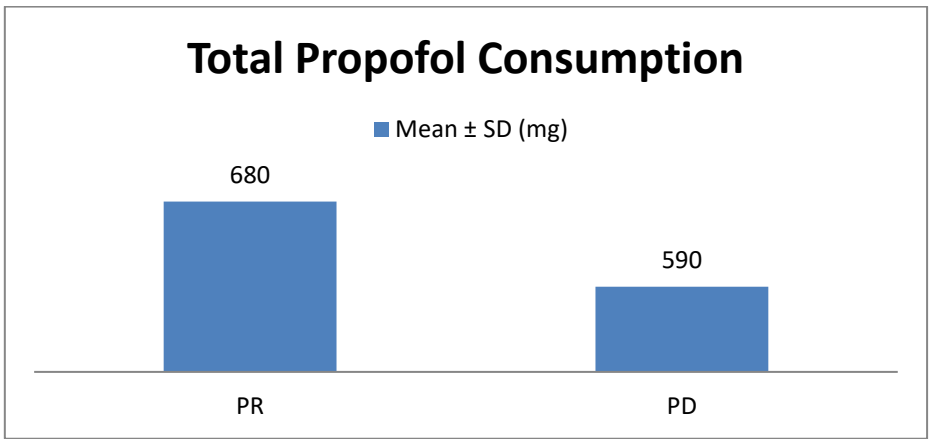


6. Total Propofol Consumption

Group PD had significantly lower total Propofol usage, indicating a Propofol-sparing effect of Dexmedetomidine (Table 6).

Table 6: Total Propofol Consumption (mg)

Group	Mean ± SD (mg)	p-value
PR	680 ± 85	
PD	590 ± 78	0.01*

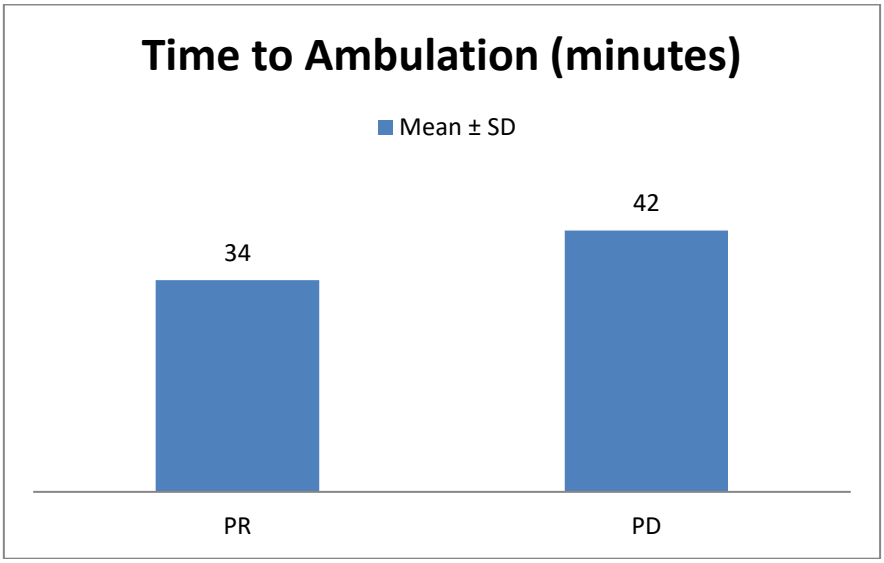


7. Time to Ambulation Postoperatively

Patients in Group PR ambulated earlier, consistent with their quicker emergence profile. However, both groups were within acceptable recovery timeframes (Table 8).

Table 7: Time to Ambulation (minutes)

Group	Mean ± SD	p-value
PR	34 ± 9	
PD	42 ± 10	0.02*

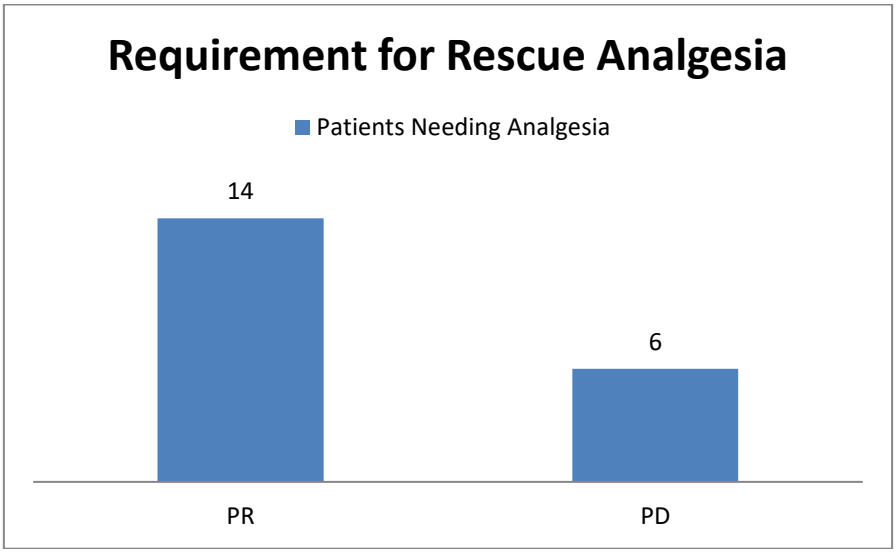


8. Requirement for Rescue Analgesia

Group PR had higher need for rescue analgesics in PACU, reflecting better analgesic effect of dexmedetomidine (Table 9).

Table 8: Rescue Analgesia Requirement (n, %)

Group	Patients Needing Analgesia	p-value
PR	14 (35%)	
PD	6 (15%)	0.03*

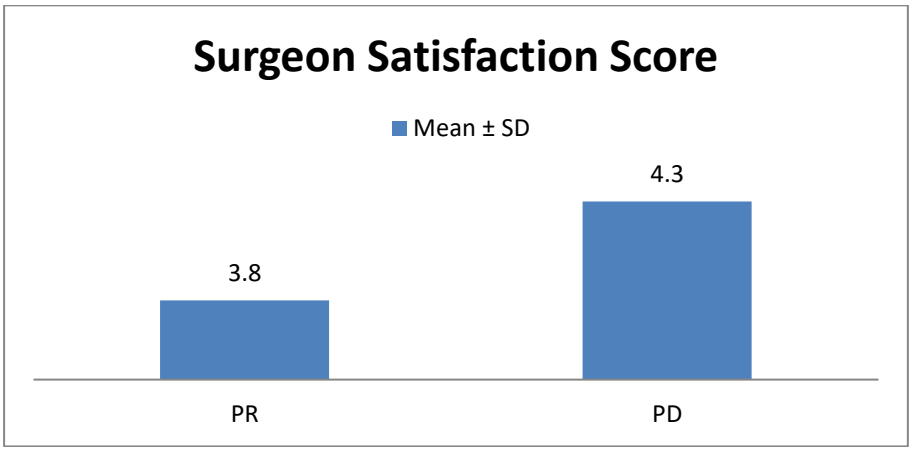


9. Surgeon Satisfaction Score

Surgeons rated Group PD cases as more stable and satisfactory due to better hemodynamic control (Table 10).

Table 9: Surgeon Satisfaction Score (1–5 scale)

Group	Mean ± SD	p-value
PR	3.8 ± 0.6	
PD	4.3 ± 0.5	0.01*



DISCUSSION

This study compared the efficacy of Propofol–Remifentanil (PR) and Propofol–Dexmedetomidine (PD) TIVA protocols in adult patients undergoing elective surgeries without neuromuscular blockade. The findings demonstrate that both regimens are effective, but with distinct clinical profiles.

Group PD exhibited significantly lower intraoperative heart rates and more stable mean arterial pressure, consistent with the sympatholytic and vasoconstrictive properties of Dexmedetomidine. These findings align with Sahoo et al. (2016), who observed enhanced hemodynamic control with Dexmedetomidine during laparoscopic surgeries [2]. Similarly, Hwang et al. (2015) reported better intraoperative stability and lower stress responses with PD compared to PR [3].

While Group PR had faster recovery in terms of eye opening and verbal response, both groups achieved acceptable recovery times. Turgut et al. (2009) also reported faster emergence with Remifentanil-based protocols but highlighted increased postoperative analgesic requirements, which was also evident in our study, where PR had higher rescue analgesia needs [10].

The incidence of hypotension and bradycardia was significantly higher in the PD group, attributed to α2-agonist-induced reductions in sympathetic tone. This is in line with findings from Bhardwaj et al. (2024) and Chinnarasan et al. (2024), who also observed a similar adverse event profile with dexmedetomidine [7, 9].

Postoperative nausea and vomiting (PONV) were more common in the PR group, likely due to Remifentanil's opioid effects. Studies by Oriby & Elrashidy (2020) and Paek et al. (2009) reported lower PONV rates with Dexmedetomidine, supporting our results [6, 5].

Our study also confirmed that Dexmedetomidine reduced total Propofol consumption, a finding supported by previous trials showing its anesthetic-sparing effect.
Notably, surgeon satisfaction was higher in the PD group due to perceived intraoperative stability, as previously noted by Tosh & Rajan (2020), highlighting Dexmedetomidine's favorable profile in surgeries requiring precise hemodynamic control [8].
In summary, Dexmedetomidine provides better intraoperative stability and analgesia, while Remifentanil enables quicker emergence. Choice of TIVA regimen should be guided by the specific surgical context and recovery priorities.

CONCLUSION

Both Propofol–Remifentanil and Propofol–Dexmedetomidine TIVA regimens effectively maintain anesthesia without muscle relaxants, with distinct benefits. Dexmedetomidine provides superior hemodynamic stability, reduced postoperative nausea, and sparing of Propofol, although it causes a higher incidence of bradycardia and hypotension. In contrast, Remifentanil offers faster emergence but leads to higher postoperative analgesic requirements. Both regimens are viable for surgeries not requiring muscle relaxants, with Dexmedetomidine being more favorable for better overall recovery and stability.

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