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Original Research Article

A comparison of effect of oral pre-medication with clonidine and metoprolol on intraoperative hemodynamics and surgical conditions during functional endoscopic sinus surgery

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Abstract

Background: Maintaining hemodynamic stability and minimizing blood loss are critical goals in perioperative care. Clonidine, an α2-adrenergic agonist, and Metoprolol, a selective β1-blocker, are frequently used to modulate cardiovascular responses during surgery. Their comparative efficacy in reducing intraoperative blood loss and supporting postoperative recovery remains a subject of clinical interest. The aim of this study was to compare the perioperative efficacy of oral clonidine and metoprolol in maintaining intraoperative hemodynamic stability, minimizing blood loss, and enhancing postoperative recovery among adult patients undergoing elective surgery under general anaesthesia.

Materials and Methods: This prospective, randomized controlled trial included 60 ASA I–II patients aged 18–60 years undergoing elective surgery under general anaesthesia. Participants were randomized to receive either oral Clonidine (0.15 mg, Group A, n=30) or Metoprolol (50 mg, Group B, n=30) two hours before surgery. Intraoperative hemodynamic parameters, estimated blood loss, surgical field quality, and postoperative outcomes including pain score, nausea incidence, recovery time, and hospital stay were recorded and statistically analysed.

Results: The intraoperative heart rate, blood pressure, and oxygen saturation remained stable in both groups, with no statistically significant differences observed ($P > 0.05$). However, the Clonidine group demonstrated a significantly lower mean intraoperative blood loss compared to the Metoprolol group (137 ± 14.71 mL vs. 151 ± 9.94 mL; $P = 0.0002$), along with superior surgical field visibility, as reflected by a higher proportion of "Good" field assessments (70% vs. 56.7%; $P = 0.041$). Postoperative parameters, including pain scores, recovery time, and duration of hospital stay, showed no significant differences between the two groups ($P > 0.05$).

Conclusion: Clonidine and Metoprolol are both effective for intraoperative hemodynamic control and postoperative recovery. However, Clonidine demonstrates a distinct advantage in minimizing blood loss and improving surgical field quality.

Keywords: Clonidine; Metoprolol; Hemodynamic stability; Blood loss; Postoperative recovery; Elective surgery.

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1. Introduction

The perioperative period is characterized by considerable physiological stress, triggered by surgical trauma and the effects of anaesthetic agents. These stimuli often provoke a surge in sympathetic nervous system activity, resulting in tachycardia, hypertension, and peripheral vasoconstriction. Such responses can contribute to increased intraoperative blood loss, poor surgical field visibility, and delayed recovery. Consequently, the pharmacological modulation of

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cardiovascular responses has become a critical component of modern anesthetic practice.

Clonidine, an α2-adrenergic agonist, exerts its effects by centrally inhibiting sympathetic nervous system activity, leading to reduced plasma norepinephrine levels. This results in lower heart rate, mean arterial pressure, and systemic vascular resistance. Its ability to stabilize intraoperative hemodynamic and reduce surgical bleeding has been supported by several studies.[1,2] Improved control of blood pressure and enhanced surgical field visibility have been noted, particularly in procedures involving the ear, nose, and throat.

In addition to hemodynamic control, clonidine possesses sedative and opioid-sparing properties that contribute to smoother emergence from anaesthesia and improved postoperative comfort, especially in outpatient surgical settings. These benefits include reduced anaesthetic requirements and better cardiovascular stability during surgery.[3]

Metoprolol, a cardio selective β1-adrenergic blocker, works by lowering heart rate and myocardial contractility, thereby decreasing oxygen demand. It is commonly used in patients with cardiovascular conditions such as ischemic heart disease and arrhythmias. Evidence from large clinical trials has shown that perioperative administration of metoprolol can reduce the incidence of myocardial infarction in non-cardiac surgeries. However, this benefit may be offset by a higher risk of complications such as stroke and mortality due to its potential to induce hypotension and bradycardia.[4]

While the MaVS trial and other studies affirmed Metoprolol's efficacy in perioperative heart rate control, concerns remain regarding its association with intraoperative hypotension and rebound tachycardia.[5] These safety considerations have prompted renewed interest in Clonidine, which may provide comparable hemodynamic control with a potentially better safety profile.[6]

Clonidine provides distinct clinical benefits in the perioperative setting, particularly by reducing intraoperative bleeding and improving the quality of the surgical field. Its ability to lower sympathetic outflow leads to vasodilation and decreased capillary bleeding, which can be especially valuable in procedures requiring a clear operative view, such as endoscopic or laparoscopic surgeries. Moreover, clonidine's sedative properties contribute to anaesthetic-sparing effects, promoting more stable intraoperative conditions. In contrast, while metoprolol effectively controls heart rate, its limited impact on operative visibility and anaesthetic requirements may restrict its advantage in surgeries where blood conservation and field clarity are priorities.[7,8]

In the postoperative setting, clonidine offers continued advantages by mitigating sympathetic overactivity, thereby reducing the incidence of rebound hypertension and diminishing analgesic requirements. Its intrinsic sedative effects also contribute to smoother recovery and reduced need for adjunct medications.[9] Conversely, while metoprolol maintains heart rate control, its lack of analgesic and anxiolytic properties limits its effectiveness in addressing postoperative pain and stress, often necessitating additional pharmacologic support.

Despite promising findings, existing literature is heterogeneous with respect to sample sizes, methodologies, and outcome measures, making direct comparisons challenging. To address this gap, the present study was designed as a prospective, randomized controlled trial to compare the perioperative efficacy of oral clonidine (0.15 mg) and metoprolol (50 mg) in patients undergoing elective surgery under general anaesthesia. The study assessed intraoperative parameters such as hemodynamic stability, blood loss, and surgical field quality, as well as postoperative outcomes including pain scores, recovery time, and hospital stay.

2. Materials and Methods

This study was approved by the Institutional Ethics Committee (Approval No. VMKVMC&H/IEC/21/034) and prospectively registered with the Clinical Trials Registry of India (CTRI/2022/01/039572). It was conducted over a period of 15 months. Adults aged 18 to 60 years scheduled for elective surgery under general anesthesia were eligible to participate. Only patients with American Society of Anesthesiologists (ASA) physical status I or II were included. Written informed consent was obtained from all participants prior to enrollment. Exclusion criteria included a history of cardiovascular, renal, hepatic, or respiratory conditions; prior use of β-blockers or clonidine within the past month; pregnancy or lactation; and known contraindications to general anesthesia.

The required sample size was calculated using a power analysis based on previously reported differences in intraoperative blood loss between clonidine and metoprolol groups. Assuming a mean difference of 15 mL in blood loss with a standard deviation of 18 mL, an effect size of 0.8 was estimated. With a power of 80% and a two-sided alpha level of 0.05, the minimum sample size per group was determined to be 26. To account for potential dropouts and ensure sufficient statistical power, 60 patients were recruited and randomly allocated in equal numbers to Group A (Clonidine, n = 30) and Group B (Metoprolol, n = 30).

Randomization was performed using computer-generated block methods, with the allocation sequence concealed within sealed opaque envelopes, opened only during surgery. The staff administering premedication were not involved in intraoperative observation or postoperative evaluation. Double blinding was implemented, ensuring that

both data collectors and treated subjects were blinded to group assignments, thus preserving the integrity of the study.

Prior to surgery, all participants were instructed to fast overnight. On the day of surgery, patients received their assigned medications two hours before their scheduled procedure. Group A participants were given 0.15 mg of Clonidine orally with 30 mL of water, while Group B participants received 50 mg of oral Metoprolol with 30 mL of water. As part of standard premedication, all patients were given intravenous glycopyrrolate (0.2 mg) and ondansetron (8 mg) before anaesthesia.

Monitoring in the operating room followed standard protocols, including electrocardiography, non-invasive blood pressure measurements, and pulse oximetry. Baseline readings were recorded. To facilitate endotracheal intubation, patients received a combination of intravenous fentanyl (2 mcg/kg), propofol (2 mg/kg), and vecuronium (0.1 mg/kg). During maintenance anaesthesia, patients were administered a 66% nitrous oxide and 33% oxygen mixture, along with isoflurane at 0.8–1.0%. Intravenous Ringer's lactate was infused at 10 mL/kg/hour for the first hour, then reduced to 5 mL/kg/hour. Heart rate, systolic and diastolic blood pressures, respiratory rate, and oxygen saturation were measured at baseline, immediately after induction, and at regular intervals (0, 20, 60, 120, and 180 minutes).

Intraoperative blood loss was measured using a hemoglobin-based method. To prevent clotting, heparin (1:250,000) was added to the suction canister at the beginning of surgery. All fluid collected in the suction bottle was recorded. Blood loss estimation was based on the patient's mean hemoglobin value and the hemoglobin concentration of the collected fluid, following standard calculation procedures.

The operating surgeon independently evaluated the surgical field using the Average Category Scale (ACS), originally proposed by Fromme et al. for assessing operative field quality in controlled hypotension during orthognathic surgery.[10] Boezaart et al. later adapted the ACS for use in endoscopic sinus surgeries, to assess the impact of pharmacological agents on intraoperative bleeding and visibility.[11] The ACS categorizes surgical field conditions as follows: Good (Grade 0–1), requiring minimal or no suction; Fair (Grade 2–3), requiring intermittent suction; and Poor (Grade 4–5), requiring continuous suction due to excessive bleeding.

Recovery time, VAS pain scores, frequency of nausea, need for postoperative analgesia, and time to first analgesic administration were all measured until hospital discharge. Intravenous paracetamol (1 g) was administered as rescue analgesia when VAS scores reached 4 or higher.

Statistical analysis was conducted using EPI Info version 7.2. Continuous variables were assessed for normal distribution before analysis, with either the independent samples t-test or Mann–Whitney U test applied based on data characteristics. Categorical variables were analyzed using Chi-square or Yates' corrected Chi-square tests. Statistical significance was determined based on p-values less than 0.05.

3. Result

A total of 60 patients were enrolled in this prospective, randomized controlled study to compare the perioperative effects of oral clonidine (0.15 mg) and oral metoprolol (50 mg) in adults undergoing elective surgery under general anesthesia. Participants were randomly assigned into two equal groups: Group A (Clonidine, n = 30) and Group B (Metoprolol, n = 30). This study aimed to compare the efficacy of oral clonidine and metoprolol in maintaining perioperative hemodynamic stability, minimizing intraoperative blood loss, and evaluating postoperative recovery profiles. The findings from the randomized trial are outlined below.

Table 1: Demographic and baseline characteristics of study participants

Parameter	**Group A (Clonidine) (N = 30) ***	**Group B (Metoprolol) (N = 30)***	**P-value**
Mean Age (years)	37.07 ± 11.62	35.83 ± 10.77	0.6785
Gender (Female / Male)	20 / 10 (66.67% / 33.33%)	23 / 7 (76.67% / 23.33%)	0.356
ASA Grade I / II	27 / 3 (90% / 10%)	26 / 4 (86.67% 13.33%)	>0.05
Height (cm)	156.16 ± 7.12	155.86 ± 8.51	0.9941
Weight (kg)	62.09 ± 10.57	59.22 ± 9.69	0.1185
Preoperative Hemoglobin (g%)	11.86 ± 2.51	11.73 ± 2.08	0.922
Random Blood Sugar (mg/dL)	96.4 ± 14.2	98.1 ± 15.0	0.523
Serum Creatinine (mg/dL)	0.89 ± 0.12	0.91 ± 0.14	0.617
Serum Sodium (mEq/L)	138.2 ± 3.5	137.8 ± 3.8	0.752
Serum Potassium (mEq/L)	4.2 ± 0.4	4.1 ± 0.3	0.644
ECG Normal / Abnormal	28 / 2 (93.33% / 6.67%)	27 / 3 (90% / 10%)	0.482
Chest X-ray Normal / Abnormal	29 / 1 (96.67% / 3.33%)	28 / 2 (93.33% / 6.67%)	0.395

*****Data are expressed as mean ± SD or number (%).

The demographic and baseline characteristics of the study participants were comparable between Group A (Clonidine) and Group B (Metoprolol), as shown in **Table 1**. There were no statistically significant differences in mean age, gender distribution, ASA classification, height, weight, or preoperative laboratory parameters, including hemoglobin levels, random blood sugar, serum creatinine, and electrolytes ($P > 0.05$ for all variables).

The similarity in demographic, physical, and biochemical characteristics between the two groups confirms a well-balanced randomization process, ensuring a valid comparison of perioperative hemodynamic and recovery outcomes.

The intraoperative hemodynamic and respiratory parameters were monitored at multiple time points, including preoperative (Preop), immediately after induction (0 min), and at subsequent intervals up to 180 minutes. Both Group A (Clonidine) and Group B (Metoprolol) maintained stable heart rates, systolic and diastolic blood pressures, respiratory rates, and oxygen saturation levels throughout the surgical period (**Table 2**, **Figure 1**). No statistically significant differences were observed between the two groups for any hemodynamic or respiratory parameters at any time point ($P > 0.05$ for all comparisons).

Both groups exhibited a gradual reduction in heart rate and blood pressure over time, with no clinically significant variations between Group A (Clonidine) and Group B (Metoprolol). This indicates that both drugs effectively control intraoperative hemodynamics, ensuring stable cardiovascular function throughout surgery. Respiratory function remained stable in both groups, with no significant respiratory depression observed. Oxygen saturation levels were consistently above 98%, reinforcing the safety profile of both drugs in maintaining adequate oxygenation during the perioperative period.

Table 2: Hemodynamic and respiratory parameters during surgery: Group A: Clonidine (N = 30), Group B: Metoprolol (N = 30)

Time Point (min)	HR (bpm) Group A	HR (bpm) Group B	SBP (mmHg) Group A	SBP (mmHg) Group B	DBP (mmHg) Group A	DBP (mmHg) Group B	RR (breaths/ min) Group A	RR (breaths/min) Group B	SpO_2 (%) Group A	SpO_2 (%) Group B
Preoperative	84.86 ± 12.07	81.13 ± 13.68	124.8 ± 13.8	119.7 ± 13.7	74.96 ± 10.01	72.13 ± 9.78	16.2 ± 1.8	16.5 ± 1.6	98.1 ± 1.2	98.0 ± 1.1
0	84.63 ± 14.05	78.83 ± 12.23	116.8 ± 14.11	109.8 ± 15.43	73.56 ± 11.07	70.46 ± 10.99	16.0 ± 1.7	16.3 ± 1.8	98.2 ± 1.1	98.1 ± 1.0
5	84.00 ± 14.73	79.16 ± 12.40	118.66 ± 20.2	104.3 ± 12.08	69.13 ± 13.1	66.84 ± 12.7	15.9 ± 1.9	16.1 ± 1.5	98.3 ± 1.0	98.2 ± 1.1
10	84.13 ± 12.70	78.86 ± 14.55	113.5 ± 18.58	103.0 ± 9.7	67.06 ± 15.81	65.92 ± 13.44	15.8 ± 1.8	16.0 ± 1.6	98.1 ± 1.2	98.1 ± 1.1
15	85.46 ± 11.47	80.53 ± 15.59	113.5 ± 18.86	109.56 ± 17.69	67.2 ± 13.61	66.1 ± 14.32	15.7 ± 1.6	15.9 ± 1.7	98.2 ± 1.2	98.1 ± 1.0
20	87.13 ± 10.51	80.50 ± 13.62	112.4 ± 16.99	105.1 ± 15.4	65.4 ± 12.73	64.8 ± 12.65	15.6 ± 1.8	15.8 ± 1.6	98.1 ± 1.2	98.0 ± 1.1
60	79.40 ± 10.6	76.83 ± 14.95	104.0 ± 19.37	97.9 ± 10.96	61.16 ± 15.2	59.92 ± 14.75	15.5 ± 1.7	15.6 ± 1.5	98.3 ± 1.0	98.2 ± 1.1
120	84.80 ± 12.7	81.13 ± 13.68	124.8 ± 13.48	119.7 ± 13.72	74.96 ± 10.01	72.18 ± 10.22	15.6 ± 1.9	15.8 ± 1.7	98.2 ± 1.1	98.1 ± 1.0
180	79.40 ± 10.6	76.80 ± 14.95	104.0 ± 19.37	97.9 ± 10.96	61.1 ± 15.2	59.4 ± 14.62	15.4 ± 1.6	15.7 ± 1.5	98.3 ± 1.0	98.2 ± 1.1

Values are expressed as mean ± SD.

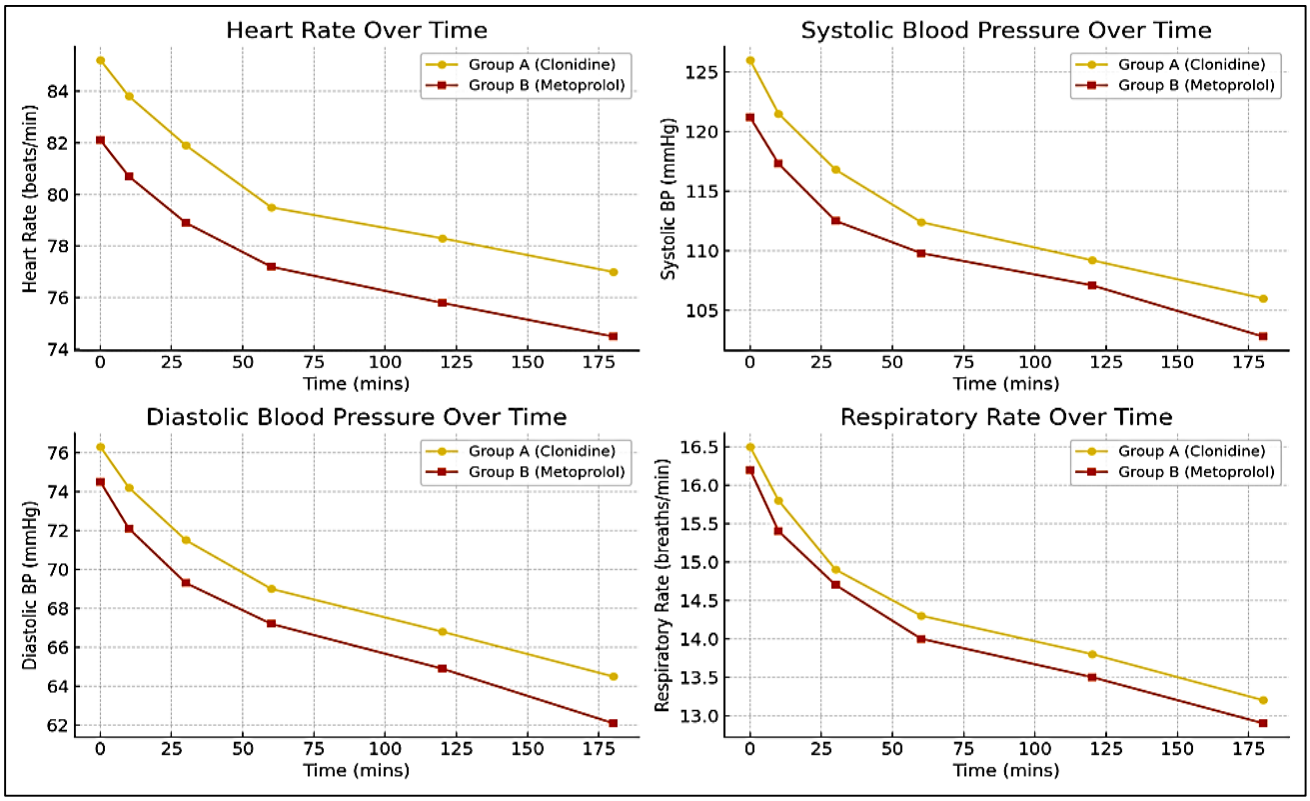

Figure 1: Shows mean values ± SD for heart rate, systolic and diastolic blood pressure, and respiratory rate across time points. No significant intergroup differences were observed (P > 0.05)

Table 3: Hemoglobin and blood loss indicators

Parameter	Group A (Clonidine)*	Group B (Metoprolol)*	p-value
Preoperative Hemoglobin (g%)	11.86 ± 2.51	11.73 ± 2.08	0.922
Postoperative Hemoglobin (g%)	11.4 ± 2.28	10.93 ± 2.09	0.3995
Mean Hemoglobin (g%)	11.32 ± 2.12	10.96 ± 2.15	0.425
Hemoglobin in Canister (g%)	8.16 ± 1.76	7.66 ± 1.68	0.292
Suction Volume (ml)	193.76 ± 34.53	219.33 ± 31.53	0.0011
Blood Loss (ml)	137 ± 14.71	151 ± 9.94	0.0002
Haematocrit Preop (%)	35.2 ± 3.1	34.8 ± 2.9	0.521
Haematocrit Postop (%)	33.8 ± 2.9	32.9 ± 3.0	0.486
Estimated Blood Loss Adjusted for Haematocrit (ml)	140.3 ± 12.8	155.7 ± 11.5	0.038

***Values are expressed as mean ± SD.

Table 4: Surgical field quality assessment (ACS grading)

ACS Grade	Group A (Clonidine) *	Group B (Metoprolol) *	p-value
Good (ACS 0-1)	21 (70%)	17 (56.67%)	0.041
Fair (ACS 2-3)	8 (26.67%)	10 (33.33%)	-
Poor (ACS 4-5)	1 (3.33%)	3 (10%)	-

***Values represent the number (%) of patients in each ACS grade category.

Preoperative and postoperative hemoglobin levels, mean hemoglobin concentration, and hematocrit values were comparable between the two groups (P > 0.05), indicating similar overall hemoglobin stability (**Table 3**). However, suction volume and total blood loss were significantly lower in Group A (Clonidine) compared to Group B (Metoprolol), both before and after adjusting for hematocrit levels (P < 0.05).

In addition, a higher percentage of "Good" surgical field conditions was observed in the Clonidine group (70%) compared to the Metoprolol group (56.67%) (P = 0.041), as shown in **Table 4**. This suggests that Clonidine may contribute to better operative visibility and reduced bleeding, highlighting its potential advantage in managing intraoperative blood loss.

Clonidine resulted in lower blood loss, improved surgical field conditions, and better intraoperative visibility, while hemoglobin levels remained stable in both groups.

Intraoperative hemodynamic stability was assessed through repeated measures ANOVA, correlation analysis, variability measures (CV), and time-to-event analysis for hemodynamic instability. As shown in

Table 5, both Clonidine (Group A) and Metoprolol (Group B) maintained stable heart rate, systolic blood pressure, diastolic blood pressure, respiratory rate, and oxygen saturation over time, with no significant intraoperative fluctuations observed ($P > 0.05$).

Correlation analysis revealed a moderate positive correlation between heart rate and blood pressure at different time points, with no statistically significant differences between the two groups ($P > 0.05$). This suggests a predictable cardiovascular response under both treatment conditions. Similarly, the coefficient of variation (CV) for heart rate, systolic blood pressure, and diastolic blood pressure showed low variability, reinforcing the stability and reliability of both drugs in perioperative cardiovascular control ($P > 0.05$).

Time-to-event analysis demonstrated that the incidence of blood pressure drops, heart rate spikes, respiratory rate changes, and oxygen saturation drops was comparable between the two groups, with no statistically significant differences ($P > 0.05$). These findings indicate that neither drug increases the risk of hemodynamic instability, supporting their clinical safety and efficacy in perioperative management.

The subgroup analysis further examined heart rate and systolic blood pressure variations across different demographic categories, including age (<40 vs. ≥40 years), gender, and ASA classification (I vs. II). As shown in **Table 6**: Subgroup analysis by demographics, no statistically significant differences were observed between Group A (Clonidine) and Group B (Metoprolol) across all subgroups ($P > 0.05$). Among participants younger than 40 years, the heart rate and systolic blood pressure values were slightly higher in the Clonidine group compared to Metoprolol, but the differences were not statistically significant ($P = 0.15$ and $P = 0.18$, respectively). Similarly, in participants aged 40 years or older, both parameters remained comparable between the two groups ($P = 0.22$ and $P = 0.16$, respectively). Gender-based comparisons revealed similar heart rate trends in both male and female participants, with no significant variations ($P = 0.33$ and $P = 0.21$, respectively). Additionally, ASA grade I and II patients exhibited similar systolic blood pressure values between the groups, indicating that both Clonidine and Metoprolol provide stable hemodynamic control across different ASA classifications.

These findings further confirm that both drugs maintain consistent hemodynamic stability, irrespective of age, gender, or ASA classification, supporting their generalizability and safety for a diverse perioperative patient population.

Table 5: Hemodynamic stability and time-to-event analysis

Parameter / Time	Group A (Clonidine)*	Group B (Metoprolol)*	p-value
Heart Rate (F-Statistic)	1.53	1.53	0.14
Systolic Blood Pressure (F-Statistic)	1.11	1.11	0.22
Diastolic Blood Pressure (F-Statistic)	0.97	0.97	0.34
Respiratory Rate (F-Statistic)	1.18	1.18	0.21
Oxygen Saturation (F-Statistic)	0.76	0.76	0.42
Preop Correlation (HR & BP)	0.45	0.42	0.67
0 min Correlation	0.48	0.43	0.62
10 mins Correlation	0.52	0.49	0.59
30 mins Correlation	0.46	0.44	0.64
120 mins Correlation	0.51	0.53	0.73
Heart Rate Variability (CV)	0.13	0.14	0.31
Systolic BP Variability (CV)	0.11	0.12	0.27
Diastolic BP Variability (CV)	0.14	0.13	0.34
BP Drop (>20% from Baseline)	5 events	7 events	0.42
Heart Rate Spike (>20 bpm)	3 events	4 events	0.55
Respiratory Rate Change	2 events	2 events	1.00
Oxygen Saturation Drop (<95%)	1 event	1 event	1.00

*****Values are expressed as F-statistics, correlation coefficients, coefficients of variation (CV), or event counts.

Table 6: Subgroup analysis by demographics

Subgroup	Parameter	Group A (Clonidine) *	Group B (Metoprolol) *	p-value
Age < 40	Heart Rate (beats/min)	83.5 ± 11.8	80.1 ± 12.3	0.15
	Systolic BP (mmHg)	123.4 ± 14.2	118.5 ± 13.7	0.18
Age ≥ 40	Heart Rate (beats/min)	84.9 ± 12.5	82.6 ± 14.1	0.22
	Systolic BP (mmHg)	125.7 ± 13.6	120.4 ± 13.2	0.16
Gender: Male	Heart Rate (beats/min)	82.9 ± 10.4	81.2 ± 13.8	0.33
Gender: Female	Heart Rate (beats/min)	85.2 ± 12.9	82.1 ± 13.2	0.21
ASA Grade I	Systolic BP (mmHg)	122.6 ± 13.9	118.3 ± 14.4	0.24
ASA Grade II	Systolic BP (mmHg)	124.9 ± 14.1	121.4 ± 13.7	0.26

*****Values are expressed as mean ± SD.

Table 7: Analysis of postoperative outcomes

Outcome	Group A (Clonidine) *	Group B (Metoprolol)*	Statistical Analysis	p-value
Recovery Time (mins)	45.3 ± 10.5	46.8 ± 9.7	T-test	0.48
Pain Score (VAS 0-10)	3.2 ± 1.1	3.5 ± 1.0	Mann-Whitney U	0.38
Postoperative Nausea (%)	10%	12%	Chi-square test	0.72
Length of Hospital Stay (days)	2.5 ± 0.8	2.6 ± 0.7	T-test	0.55
Postoperative analgesic requirement (mg)	80.5 ± 12.3	85.2 ± 14.1	T-test	0.42
Time to First Analgesia (hrs)	4.2 ± 1.6	3.9 ± 1.8	T-test	0.47

*****Values are expressed as mean ± SD or percentage. No statistically significant differences were observed between groups for any postoperative recovery parameters (P > 0.05).

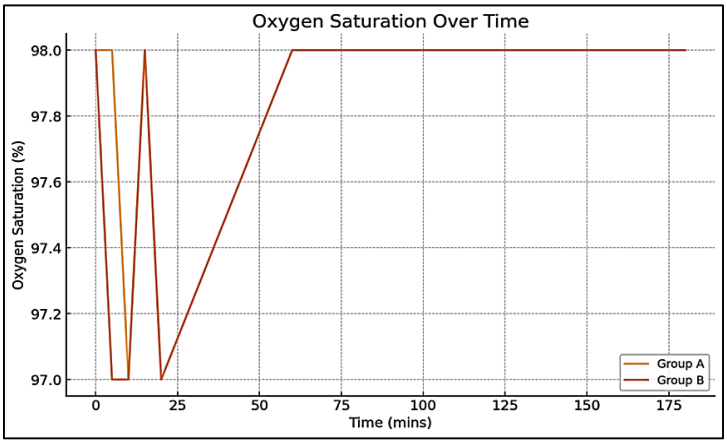

Figure 2: Line graph for oxygen saturation over time

The postoperative recovery parameters, including recovery time, pain scores, nausea incidence, and hospital stay duration, were assessed between Group A (Clonidine) and Group B (Metoprolol). There were no significant differences in recovery time (P = 0.48), pain scores (P = 0.38), nausea incidence (P = 0.72), or hospital stay duration (P = 0.55) between the groups (**Table 7**).

Additionally, postoperative analgesic requirements and time to first analgesia administration were evaluated, showing no significant variations between the groups (P > 0.05). The comparable analgesic consumption and similar timing of initial analgesia administration further suggest equivalent pain management effectiveness between Clonidine and Metoprolol.

These findings indicate that both drugs provide similar postoperative recovery profiles, without adversely affecting pain control, nausea incidence, or length of hospital stay, supporting their clinical utility in perioperative care.

The trend of oxygen saturation levels over time in both groups demonstrated that oxygen saturation remained consistently high throughout the intraoperative period, with no clinically significant desaturation observed in either group. These findings indicate that both Clonidine and Metoprolol maintain stable respiratory function and are safe with respect to preserving adequate oxygenation during surgery (**Figure 2**).

Oxygen saturation values are shown as mean ± SD. Both groups maintained consistently high SpO_2 levels throughout surgery, with no significant desaturation events (P > 0.05).

4. Discussion

This randomized controlled trial was conducted to evaluate and compare the perioperative efficacy of oral clonidine and metoprolol in adult patients undergoing elective surgery under general anesthesia. The primary aim was to assess their impact on intraoperative hemodynamic stability, surgical field visibility, and postoperative recovery outcomes. Both medications effectively maintained stable intraoperative blood pressure and heart rate, with comparable postoperative recovery profiles. However, clonidine demonstrated a significant advantage by reducing intraoperative blood loss and enhancing surgical field conditions, suggesting its potential superiority in surgeries where blood conservation and optimal visibility are critical.[12]

The findings demonstrated that both clonidine and metoprolol maintained stable intraoperative parameters, including blood pressure, heart rate, and oxygen saturation. However, surgical field visibility was generally more favourable in the clonidine group, which also experienced less intraoperative bleeding. This effect is attributed to clonidine's ability to reduce sympathetic nervous system activity and limit catecholamine release. In comparison, metoprolol efficiently controlled heart rate, consistent with its role as a β1-selective adrenergic blocker, though this did not always translate into improved visibility during surgery. The assessment of surgical field quality showed fewer instances of poor visibility in the clonidine group compared to the metoprolol group. These observations reinforce the role of clonidine in optimizing the surgical environment by minimizing bleeding while preserving hemodynamic stability. Overall, clonidine appears to offer a more favourable profile for enhancing intraoperative conditions during functional endoscopic sinus surgery. The different drug profiles of these medications explain the observed variations during these experiments. Clonidine works centrally by activating α2-adrenergic receptors, which decreases sympathetic nerve output and lowers systemic vascular resistance, thus reducing bleeding primarily at the capillary level.[13] In contrast, metoprolol primarily affects heart rate and cardiac output, with minimal impact on peripheral vasculature.[13,14]

A comparative summary of key studies conducted between 2015 and 2025, evaluating the perioperative use of clonidine and metoprolol across various surgical procedures, is presented in **Table 8**. Notably, most studies consistently report that clonidine offers superior control over intraoperative bleeding and enhances surgical field visibility, while metoprolol is more effective in heart rate regulation. These findings support the current study's conclusion that clonidine may be the preferred agent in surgeries where blood conservation and operative clarity are critical.

Table 8: Comparative summary of studies evaluating clonidine vs. metoprolol for perioperative use[15-19]

Study	Sample Size	Surgical Procedure	Clonidine Dose	Metoprolol Dose	Key Findings
Naithani et al.[15]	68 (34 per group)	Functional Endoscopic Sinus Surgery (FESS)	300 µg orally, 2 hrs pre-op	50 mg orally, 2 hrs pre-op	Clonidine group had significantly lower MAP, improved surgical field, and reduced anesthetic requirement.
Dhakne et al.[16]	80 (40 per group)	FESS	3 µg/kg orally, 90 min pre-op	50 mg orally, 90 min pre-op	Clonidine significantly reduced intraoperative blood loss; Metoprolol provided better HR control.
Menezes et al.[17]	46 total	ENT Head & Neck Surgery	75–150 µg orally	5–10 mg orally	Clonidine more effective in lowering postoperative SBP/DBP; Metoprolol group had higher incidence of postoperative hypertension.
Keshari et al.[18]	60 (30 per group)	FESS	150 µg orally, 2 hrs pre-op	100 mg orally, 2 hrs pre-op	Clonidine provided better hemodynamic control, improved surgical field, higher surgeon satisfaction, and better sedation; more hypotension but not significant.
Jiwanmall et al.[0]	60 (30 per group)	FESS	3 µg/kg IV, 30 min pre-induction	Not given (placebo group)	IV clonidine significantly improved blood loss, surgical field visibility, analgesia, and reduced metoprolol and fentanyl requirements.
Present Study (2025)	60 (30 per group)	Elective surgeries under general anesthesia	150 µg orally, 2 hrs pre-op	50 mg orally, 2 hrs pre-op	Clonidine significantly reduced blood loss and improved surgical field visibility. Both drugs provided stable hemodynamics and similar postoperative recovery.

Table summarizes key findings from selected studies (2015–2025) comparing clonidine and metoprolol in perioperative settings.

Clonidine has been shown to stabilize blood pressure after surgery and prevent rebound hypertension, an effect not consistently observed with metoprolol.[15] Both treatment groups demonstrated similar postoperative outcomes in terms of pain scores, recovery duration, nausea incidence, and length of hospital stay.[16] It has also been reported that patients who received clonidine required fewer postoperative analgesics, although their emergence time and hospitalization period remained unaffected.[17] The lack of significant differences in these variables may be attributed to standardized pain management protocols and the brief duration of surgical procedures.[18-19]

Subgroup analysis revealed no statistically significant differences in heart rate or systolic blood pressure between the clonidine and metoprolol groups across variables such as age, gender, and ASA classification. In patients under 40 years of age, the mean heart rate was 83.5 ± 11.8 bpm in the clonidine group and 80.1 ± 12.3 bpm in the metoprolol group (P = 0.15), while systolic blood pressure averaged 123.4 ± 14.2 mmHg and 118.5 ± 13.7 mmHg, respectively (P = 0.18). Among those aged 40 years and older, both heart rate and systolic blood pressure remained statistically comparable (P = 0.22 and P = 0.16, respectively). Gender-based comparisons also showed no significant differences, with males recording heart rates of 82.9 ± 10.4 bpm (clonidine) and 81.2 ± 13.8 bpm (metoprolol) (P = 0.33), and females 85.2 ± 12.9 bpm vs. 82.1 ± 13.2 bpm (P = 0.21). Similarly, systolic blood pressure among ASA grade I and II patients showed no meaningful variation between the two groups (P = 0.24 and P = 0.26, respectively). These data suggest that both medications effectively maintained hemodynamic stability across diverse demographic profiles. Additionally, previous studies have shown that clonidine enhances surgical field visibility without increasing the incidence of bradycardia or hypotension, reinforcing its intraoperative safety profile.[20,0]

The clinical implications of these findings are notable. Clonidine offers multiple intraoperative benefits, including stress reduction, analgesia, and sedation, which are particularly valuable when surgical precision and blood conservation are critical.

Intraoperative administration of clonidine was associated with significantly reduced blood loss (137 ± 14.71 mL vs. 151 ± 9.94 mL, P = 0.0002) and improved surgical field visibility, with 70% of patients achieving a “Good” field compared to 56.67% in the metoprolol group. Despite these intraoperative advantages, there were no notable differences in postoperative recovery outcomes between the two treatment groups. These results support a preference for clonidine in surgeries, where minimizing bleeding and optimizing field clarity are paramount. Moreover, its low cost and oral formulation make it highly suitable for implementation in public healthcare systems and resource-constrained settings.

Some limitations were noted in the study design. It was conducted at a single center with a relatively small sample size and excluded patients classified as high-risk (ASA III–IV). Although a validated scale was used to assess surgical field quality, it relied on subjective evaluation. Moreover, the study did not explore long-term cardiovascular outcomes, sedative effects, or postoperative functional recovery.

5. Conclusion

Clonidine and metoprolol both provide effective perioperative hemodynamic control and support safe postoperative recovery. Clonidine offers a distinct advantage by reducing intraoperative blood loss and enhancing surgical field visibility. It emerges as a preferable agent in procedures where blood conservation and operative clarity are critical.

6. Source of Funding

None.

7. Conflict of Interest

None.

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